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Report of Professor Thomas McGuire

Regarding Public Nuisance

March 25, 2019

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I. Introduction

A. Qualifications

1. My name is Thomas McGuire and I am a Professor of Health Economics in the Department of Health Care Policy at Harvard Medical School, where I teach health economics in Harvard University's Ph.D. Program in Health Policy. In 2008, I received the Everett Mendelsohn Excellence in Mentoring Award from Harvard's Graduate School of Arts and Sciences. I received an A.B. degree from Princeton University in 1971 and a Ph.D. degree in economics from Yale University in 1976.
2. I am a member of the National Academy of Medicine – formally, the Institute of Medicine (IOM) – and a Research Associate at the National Bureau of Economic Research. I served for ten years as an editor of the leading journal in the field of health economics, the *Journal of Health Economics* and co-edited the *Handbook of Health Economics*, Volume II.
3. For more than 40 years I have conducted research on the economics of managed care, health insurance, health care payment systems, drug pricing and procurement, the economics of health care disparities by race and ethnicity, and the economics of behavioral healthcare. I have recently authored a series of published papers on the economics of drug prices, competition between branded and generic drug products, and insurance coverage for drugs.¹ I

¹ T.G. McGuire and S. Bauhoff, "Adoption of a Cost-Saving Innovation: Germany, UK and Simvastatin," in N. Klusen, F. Verheyen, and C. Wagner, eds., *England and Germany in Europe – What Lessons Can We Learn from Each Other?* Baden-Baden, Germany: Nomos, 2011, pp. 11-26; E.R. Berndt, T.G. McGuire, and J.P. Newhouse, "A Primer on the Economics of Prescription Pharmaceutical Pricing in Health Insurance Markets," *Forum for Health Economics & Policy*, 14(2), 2011, Article 10; J. Glazer and T.G. McGuire, "A Welfare Measure of 'Offset Effects' in Health Insurance," *Journal of Public Economics*, 96, 2012, pp. 520-523; J. Glazer, H. Huskamp, and T.G. McGuire, "A Prescription for Drug Formulary Evaluation: An Application of Price Indexes," *Forum for Health Economics and Policy*, 15(2), 2012, Article 3; K. Drake, M. Starr, and T. McGuire, "Do 'Reverse Payment' Settlements Constitute an

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co-chaired three conferences on the Industrial Organization of Health Care and edited special sections of economic journals in which the conference papers were published.² My research has been recognized by a number of awards, including the Victor Fuchs Lifetime Achievement Award for 2018, awarded by the American Society of Health Economics.³ In 2015, a jointly authored paper on reverse payment settlements in the drug industry received the Article of the Year Award from the *International Journal of the Economics of Business*.⁴

4. I have conducted research and contributed to public policy regarding behavioral health (mental and addictive illnesses) for 40 years. I was the co-chair of four conferences on economics and mental health sponsored by the National Institute of Mental Health (NIMH). I have been the recipient of investigator-initiated research projects (R01's) from the NIMH and the National Institute on Drug Abuse (NIDA). My research in behavioral health has earned a number of awards, including the Elizur Wright Award from the American Association of Risk and

Anticompetitive Pay-for-Delay?" *International Journal of the Economics of Business*, 22(2), 2015, pp. 173-200; T. McGuire, K. Drake, E. Elhauge, R. Hartman, and M. Starr, "Resolving Reverse-Payment Settlements with the Smoking Gun of Stock Price Movements," *Iowa Law Review*, 101(4), 2016, pp. 1581-1599; and K. Drake and T. McGuire, "Stock-Price Evidence for Anticompetitive Effects in the Nexium 'Reverse-Payment' Settlement," *Journal of Competition Law & Economics*, 12(4), 2016, pp. 735-747.

² T.G. McGuire and M.H. Riordan (guest editors), "The Industrial Organization of Health Care," *Journal of Economics & Management Strategy*, 3(1), March 1994; A. Ma, T.G. McGuire, and M.H. Riordan (guest editors), "The Industrial Organization of Health Care, II," *Journal of Economics & Management Strategy*, 6(1), Spring 1997; and A. Ma and T.G. McGuire (guest editors), "The Industrial Organization of Health Care, III," *Journal of Economics & Management Strategy*, 8(3), Fall 1999.

³ Two of my jointly authored papers received "Best Paper of the Year" awards in 2008, one from Academy Health for research on physician-patient interaction and one from the National Institute for Health Care Management for work on incentives in managed care plans. My paper on designing payment systems for private health insurance markets received the best paper of the year award in 2014 from the National Institute for Health Care Management.

⁴ K. Drake, M. Starr, and T. McGuire, "Do 'Reverse Payment' Settlements Constitute an Anticompetitive Pay-for-Delay?" *International Journal of the Economics of Business*, 22(2), 2015, pp. 173-200.

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Insurance recognizing “an outstanding contribution to the literature on risk and insurance” for my *Financing Psychotherapy* (1981), and the Carl Taube Award from the American Public Health Association for “outstanding contributions to public health” (1991). I have supervised numerous Ph.D. dissertations on the economics of behavioral health at Boston University, Brandeis University and Harvard University. I was the director of two NIMH-funded pre- and post-doctoral training programs in the economics of mental health and the economics of mental health policy. My research has directly contributed to the design of health insurance and provider payment in behavioral health care.

5. My litigation experience includes recent testimony at two drug industry antitrust trials.⁵ Appendix A contains my CV and a list of my recent testimony. My rate of compensation in this matter is \$900 per hour. My compensation does not depend upon the outcome of this litigation.

B. Assignment

6. In connection with the public nuisance claims raised by Cuyahoga County and Summit County (Bellwether Plaintiffs), I have been asked the following three questions:⁶

⁵ *In re: Nexium (esomeprazole) Antitrust Litigation*, United States District Court for the District of Massachusetts, MDL No. 2409, Civil Action No. 112-cv-11711, November 7 and 20, 2014, and *In re: Solodyn (Minocycline Hydrochloride) Antitrust Litigation*, United States District Court, District of Massachusetts, MDL No. 14-md-2503-DJC, March 26-27, 2018.

⁶ I have not been asked to offer an opinion on the scope or cost of programs needed to abate this nuisance, but such a report could be submitted at such time as the Court deems appropriate.

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- First, is there a framework within the area of applied microeconomics by which economists determine the existence of, and measure the extent of, what is known under the law as a “public nuisance?”
- Second (and if the answer above is “yes”), do you have an opinion to a reasonable degree of certainty in the area of applied microeconomics as to whether there is a public nuisance that resulted from the shipment of prescription opioid products into the Bellwether communities over the period 2006 to the present that has impacted those communities?
- Third (and if the answer above is “yes”), do you have an opinion of the magnitude of the economic costs imposed on the Bellwether communities over the period 2006 to 2016, the most recent period for which data are fully available, taking into account any potential economic benefits with respect to the shipments?

7. Because these questions are framed in the context of the legal term “public nuisance,” I have been instructed by counsel to be guided by the following general definition of a public nuisance:

“The definition of ‘public nuisance’ . . . is couched in broad language. According to the Restatement [(Second) of Torts], a ‘public nuisance’ is ‘an unreasonable interference with a right common to the general public.’ . . . ‘Unreasonable interference’ includes those acts that significantly interfere with public health, safety, peace, comfort, or convenience, conduct that is contrary to a statute, ordinance, or regulation, or conduct that is of a continuing nature or one which has produced a permanent or long-lasting effect upon the public right, an effect of which the actor is aware or should be aware.”⁷

⁷ *City of Cincinnati v. Beretta U.S.A. Corp.*, 768 N.E.2d 1136, 1142 (Ohio 2002). In that case, involving a public nuisance claim against the gun industry, the Court held that “the city should be permitted to bring suit against the manufacturer of a product under a public nuisance theory, when, as here, the product has allegedly resulted in widespread harm and widespread costs to the city as a whole and to its citizens individually (at 1142).” (internal

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8. Coupled with this general definition of public nuisance, I have further been instructed by counsel to be guided by the Bellwether Plaintiffs' allegations regarding their public nuisance claims. I understand that this Court has already recognized that the Bellwether Plaintiffs' public nuisance claims "allege that Defendants created and maintained a public nuisance in the marketing and distribution of prescription opioids."⁸ Furthermore, I understand the Bellwether Plaintiffs have specifically alleged that the "Defendants have created and maintained a public nuisance by marketing, distributing, and selling opioids in ways that unreasonably interfere with the public health, welfare, and safety in Plaintiff's Community, and Plaintiff and the residents of Plaintiff's Community have a common right to be free from such conduct and to be free from conduct that creates a disturbance and reasonable apprehension of danger to person and property."⁹

9. I further understand that the Bellwether Plaintiffs allege that "Defendants have created and maintained an absolute public nuisance through their ongoing conduct of marketing, distributing, and selling opioids, which are dangerously addictive drugs, in a manner which caused prescriptions and sales of opioids to skyrocket in Plaintiffs' communities, flooded Plaintiffs' communities with opioids, and facilitated and encouraged the flow and diversion of

quotations omitted). Also see *City of Cincinnati v. Deutsche Bank Nat'l Trust Co.*, 863 F.3d 474, 477 (6th Circuit 2017) ("Under Ohio law, a common law public nuisance is an unreasonable interference with a right common to the general public.") (internal quotations omitted).

⁸ See Magistrate Judge David Ruiz's Report and Recommendation, October 5, 2018 at p. 60.

⁹ Cuyahoga County, Second Amended Complaint, ¶ 1024. Similarly, see Second Amended Complaint (Summit County), ¶ 1000.

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opioids into an illegal, secondary market, resulting in devastating consequences to Plaintiffs and the residents of Plaintiffs' communities."¹⁰

10. I will use the term "Defendants' shipments of prescription opioids," or sometimes just "shipments," as a shorthand for the activity the Bellwether Plaintiffs claim constitutes a public nuisance regarding both the marketing and distribution of prescription opioids by Defendants.

C. Overview of Structure and Organization of the Report

11. In Section II, I discuss the economic analysis of a public nuisance and its relationship to an analysis of externalities. Included in this section is a discussion of the nature of negative externalities associated with shipments of prescription opioids, the role of the presence of positive effects of opioid use, and examples of public response to negative externalities. In Section III, I identify a series of harms caused by opioid shipments and quantify them for the Bellwether communities. Note that these harms are due directly to the use of prescription opioids and, indirectly, by use of non-prescription opioids (*e.g.*, heroin, fentanyl) caused by the shipments. I limit my discussion to five groups of harms: mortality, morbidity, neonatal abstinence syndrome, crime, and child maltreatment. In Section IV of this Report, I monetize these harms to the Bellwether communities. In this monetization, I also include damages incurred by the Cuyahoga and Summit County governments as calculated in my Report on damages.

¹⁰ Corrected Second Amended Complaint (Summit County), ECF No. 514, ¶ 1002. Similarly, see Cuyahoga County, Second Amended Complaint, ¶1026.

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12. Attached to this Report are a series of appendices which detail my analysis and are identified throughout this Report. In addition, throughout the Report, I reference and rely upon the work of other experts who are submitting testimony contemporaneously with this Report.¹¹

D. Summary of Opinions

13. First, I am of the opinion that there is a framework within the area of applied microeconomics by which economists can determine the existence of, and measure the extent of, what is known under the law as a “public nuisance.” Within economics there is a long tradition of analyzing the social consequences of private behaviors imposing harms on others. This economic framework provides a natural parallel with the legal notion of public nuisance. And such economic analyses are commonly used by decision makers to design policies to contend with private behavior imposing harms.

14. Second, I am of the opinion to a reasonable degree of certainty in the area of applied microeconomics that a public nuisance has resulted from the shipment of prescription opioid products into the Bellwether communities, and that this public nuisance has had a widespread, devastating, and long-lasting impact on both the individual residents of the Bellwether communities and on the Bellwether Plaintiffs themselves. This opinion is entirely consistent

¹¹ Expert Report of Professor David Cutler (hereafter Cutler Report); Expert Report of Dr. David Egilman; Expert Report of Professor Jonathan Gruber (hereafter Gruber Report); Expert Report of Dr. David Kessler (hereafter Kessler Report); Expert Report of Thomas McGuire regarding Damages (hereafter McGuire Damages Report); Expert Report of Dr. Matthew Perri (hereafter Perri Report); Expert Report of Professor Meredith Rosenthal (hereafter Rosenthal Report); Expert Report of Dr. Schumacher; and Expert Report of Dr. Nancy Young (hereafter Young Report).

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with similar analyses sponsored by numerous public and private agencies throughout the United States (albeit typically applicable to broader geographic communities).

15. Third, I am of the opinion, again to a reasonable degree of certainty in the area of applied microeconomics, that the estimated magnitude of the net economic burden imposed on the Bellwether communities over the period 2006-2016 is approximately \$20 billion. The major components of this harm, as measured in economic terms, are shown in Table 1. These dollar values of harms are net of any benefits provided by prescription opioid shipments.

Table 1
Summary of Monetary Value of Harms Due to Prescription Opioid Shipments
2006-2016
(\$millions)

Harms Due to Defendants' Shipments	Cuyahoga	Summit	Total
Excess deaths	\$11,279	\$5,377	\$16,656
Excess morbidity	\$1,376	\$587	\$1,963
Excess neonatal abstinence syndrome	\$9	\$7	\$16
Excess crimes	\$327	\$126	\$453
Excess child maltreatment	\$401	\$297	\$698
Excess costs to Bellwether governments	\$172	\$99	\$271
Totals	\$13,564	\$6,492	\$20,056

Sources: Tables 5a, 5b, 7a, 7b, 8a, 8b, 9a, 9b, 10a, 10b and 11 of this Report.

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II. The Economic Analysis of Public Nuisances

A. Public Nuisance and Negative Externalities

16. I rely on the long tradition within economics of analyzing the social consequences of private behaviors imposing costs on others. A public nuisance, in economic terms, is generally observed when an action (or set of actions) undertaken by a party (or group of parties) gives rise to overwhelming “negative externalities.” An externality “occurs whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.”¹²

17. A negative externality imposes costs on others. An example of a negative externality is pollution of a river.¹³ If a household or firm deposits waste in the river, other members of the community are harmed (*e.g.*, bear health risks, enjoy less recreational use of the river) but they are not compensated for the costs imposed on them. In economics, harms, such as health risks or loss of recreational opportunities, are regarded as a “cost” imposed on others and can sometimes be valued in dollar terms.

18. The legal concept of a public nuisance parallels the concept of a negative externality in economics. An externality is created when a private actor harms others and does not compensate others for those effects. If the negative externality satisfies the other components of the definition mentioned earlier, it qualifies as a public nuisance. “Nuisance may also be

¹² J. Gruber, *Public Finance and Public Policy*, 5th edition, 2016. p. 124.

¹³ An externality can be positive as well, that is, confer benefits on others. A neighborhood association might maintain a local park that is open to the public, benefiting those outside the immediate neighborhood as well as residents of the neighborhood.

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viewed as a form of externality that interferes with the enjoyment or use of another's property."¹⁴ The economic framework of an externality provides a natural parallel with the legal notion of a public nuisance.¹⁵

19. In a related approach, scholarship in law and economics has sometimes referred to a public nuisance as a "public bad": "The common law of public nuisance has evolved for dealing with public bads. When an agent imposes a cost, similar in amount and kind, on a group of individuals, then the harmed group can call upon a public defender to bring a public nuisance action against the agent."¹⁶ "Public bads are . . . said to emerge when a large number of parties are affected negatively and simultaneously, at the margin, by an action undertaken by an individual or group. The nature of the phenomenon is such that there is no low-cost way to insulate and partition the affected individuals in the group from the negative effect. What one group member receives, all receive."¹⁷ Public bads are a form of negative externality, and I will

¹⁴ T. Swanson and A. Kontoleon, "Nuisance (Section 2100)," in B. Bouckaert and G. de Geest (eds.), *Encyclopedia of Law and Economics*, 2000, pp. 380-402. See also, R. Cooter and T.S. Ulen (2016), *Law and Economics*, 6th Edition, Berkeley Law Books, 2, p. 183.

¹⁵ I have been instructed by counsel that unlike a private nuisance, a public nuisance does not necessarily involve interference with the use and enjoyment of land because a common law nuisance is the doing of or the failure to do something that injuriously affects the safety, health or morals of the public, or works some substantial annoyance, inconvenience or injury to the public. See Restatement (Second) of Torts (1977) § 821B (at common law, a public nuisance is defined as an unreasonable interference with rights held by the public in general, not merely with the rights or interests of a few individuals). I also understand that a public nuisance suit may be brought either by the state through its attorney general or through another public official or public agency representing the state or one of its political subdivisions through a statutory public nuisance claim, and that Cuyahoga and Summit counties both have such claims against Defendants here.

¹⁶ K. Boudreaux and B. Yandle, "Public Bads and Public Nuisance-Common Law Remedies for Environmental Decline," *Fordham Environmental Law Review*, 14(1) Article 2, 2002, pp. 55-88.

¹⁷ *Ibid.*, p. 59-60.

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use the more general term “negative externality” to characterize a public nuisance in economic terms.¹⁸

B. Prescription Opioids are Not a Typical Consumer Good

20. Patients do not choose prescription drugs for themselves. Generally, physicians decide the drug, dosage, and duration to prescribe to patients. Since the dawn of modern health economics associated with the classic article from Nobel Prize-winner Kenneth Arrow, economic analysis has recognized the special role of the physician in formulating patient demand for health care.¹⁹ The role of the physician remains a central and widely studied issue in health economics.²⁰ While generally regarded as making medical decisions on the basis of patient health outcomes, physicians are recognized, however, to be “imperfect agents” for

¹⁸ The relationship between public bad and negative externality is the same as between public good and positive externality. A public good involves positive externalities, but all externalities are not public goods. Pure public goods must be consumed in equal quantity by all and are completely non-rivalrous, *i.e.*, the consumption by one person does not affect the consumption by others. The classic papers are: P.A. Samuelson, “The Pure Theory of Public Expenditure,” *Review of Economics and Statistics*, 36, 1954, pp. 386-389, and P.A. Samuelson, “Diagrammatic Exposition of a Theory of Public Expenditure,” *Review of Economics and Statistics*, 37, 1955, pp. 350-356. Not all externalities possess these two characteristics in pure form so I use the more general term, “externality.”

¹⁹ K. Arrow, “Uncertainty and the Welfare Economics of Medical Care,” *American Economic Review*, 53(5), December 1963, pp. 941-73.

²⁰ For example, see T.G. McGuire, “Physician Agency,” in A.J. Culyer and J.P. Newhouse (eds), *Handbook of Health Economics*, 2000, chapter 9; G. Mooney and M. Ryan, “Agency in Health Care: Getting Beyond First Principles,” *Journal of Health Economics*, 12(2), July 1993, pp. 125-135; S. Vick and A. Scott, “Agency in Health Care: Examining Patients’ Preferences for Attributes of the Doctor-Patient Relationship,” *Journal of Health Economics*, 17(5), October 1998, pp. 587-605; and K.R. Brekke, R. Nuscheler, and O.R. Straume, “Gatekeeping in Health Care,” *Journal of Health Economics*, 26(1), 2007, pp. 149-170.

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patients, partly for reasons related to information²¹ and partly for reasons related to incentives.²²

21. In practice, to decide about prescription drugs, physicians are influenced by “detailing” visits by representatives of brand drug companies and other promotional activities by drug companies.²³ Brand-name drug companies spend mightily on these visits,²⁴ and undertake

²¹ To take just one aspect of this, physicians must make decisions about drug treatment based on symptom reports and clinical tests, both of which can be unreliable. Physicians make decisions based on population-wide prevalence of disorders, decisions that may not be best for the particular patient. See A. Balsa, T. McGuire and L. Meredith, “Testing for Statistical Discrimination in Health Care,” *Health Services Research*, 40(1), 2005, pp. 227-252.

²² For a general discussion, see J. Newhouse, *Pricing the Priceless: A Health Care Conundrum*, Cambridge, MA: MIT Press, 2002. One special form “incentives” in the pharmaceutical area are financial rewards manufacturers confer on physicians who liberally prescribe their product. For example, Hadland *et al.* find that there was greater opioid prescribing under Medicare Part D by physicians who received non-research-based payments related to opioid products (S.E. Hadland, *et al.*, “Association of Pharmaceutical Industry Marketing of Opioid Products to Physicians with Subsequent Opioid Prescribing,” published online at jamainternmed.2018.1999, May 14, 2018). For another example, the New York State Health Foundation found that “Physicians who received payments from opioid manufacturers prescribed more opioids to Medicare patients than physicians who did not receive any opioid-related payments.” They also found that “a higher number of opioid prescriptions was associated with more opioid-related payments to physicians” (New York State Health Foundation, “Follow the Money: Pharmaceutical Manufacturer Payments and Opioid Prescribing Patterns in New York State,” June 2018).

²³ For example, see P. Manchanda and P. Chintagunta, “Responsiveness of Physician Prescription Behavior to Salesforce Effort: An Individual Level Analysis,” *Marketing Letters*, 15(2-3), 2004, pp. 129-145; F. Gönül, *et al.*, “Promotion of Prescription Drugs and Its Impact on Physicians’ Choice Behavior,” *Journal of Marketing*, 65(3), July 2001, pp. 79-90; A. Wazana, “Physicians and the Pharmaceutical Industry: Is a Gift Ever Just a Gift?” *Journal of the American Medical Association*, 283(3), January 19, 2000, pp. 373-80; A. Fugh-Berman, “The Corporate Coauthor,” *Journal of General Internal Medicine*, 20(6), June 2005, pp. 546-48; Editorial Staff, “Pharmaceutical Marketing to Physicians: Free Gifts Carry a High Price,” *American Medical News*, June 10, 2002; P. Azoulay, “Do Pharmaceutical Sales Respond to Scientific Evidence?” *Journal of Economic & Management Strategy*, 11(4), Winter 2002, pp. 551-594; J. Avorn, M. Chen, and R. Hartley, “Scientific Versus Commercial Sources of Influence on the Prescribing Behavior of Physicians,” *American Journal of Medicine*, 73(1), July 1982, pp. 4-8; C. DeJong, *et al.*, “Pharmaceutical Industry-Sponsored Meals and Physician Prescribing Patterns for Medicare Beneficiaries,” *JAMA Internal Medicine*, 2016, 176(8), pp. 1114-22; I. Larkin, *et al.*, “Association Between Academic Medical Center Pharmaceutical Detailing Policies and Physician Prescribing,” *JAMA*, 2017, 317(17), pp. 1785-95; A. Datta and D. Dave, “Effects of Physician-Directed Pharmaceutical Promotion on Prescription Behaviors: Longitudinal Evidence,” *Health Economics*, 26, 2017, pp. 450-68; and G. Spurling, *et al.*, “Information from Pharmaceutical Companies and the Quality, Quantity, and Cost of Physicians’ Prescribing: A Systematic Review,” *PLOS Medicine*, 7(10), October 2010.

²⁴ For example, see Congressional Budget Office (CBO), “Promotional Spending for Prescription Drugs,” December 2, 2009; Families USA, “Off the Charts: Pay, Profits and Spending by Drug Companies,” Families USA Publication No. 01-104, July 2001, pp. 1-31 at 1; and M. Hurwitz and R. Caves, “Persuasion or Information? Promotion and the

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huge numbers of detailing visits.²⁵ Drug company promotional efforts can go too far, and have been put in check by national reporting requirements and ethical guidelines imposed by private organizations that limit payments and even contacts with pharmaceutical representatives.²⁶ In the context of prescription opioids, manufacturers were purveying biased information. As explained in the expert report of Dr. Matthew Perri, the information doctors were being given about the dangers of prescription opioids was in most cases false, and systematically and intentionally misleading.²⁷ Dr. Perri's report establishes, among other things, that (i) manufacturers of prescription opioids are sophisticated marketers who are skilled in applying marketing strategies and tactics to successfully target and reach their desired customers, (ii) these Defendants target multiple audiences, including patients, prescribers, insurers, formulary decision makers, wholesalers, and pharmacies, (iii) this marketing of prescription opioids expanded demand for these drugs, with increases in the volume of doses sold and the numbers of patients treated with opioids, (iv) the addictive properties of opioids make marketing of such products especially problematic because of the likelihood that market demand may be driven by tolerance, dependence, abuse or addiction, and (v) in the context of addictive substances,

Shares of Brand Name and Generic Pharmaceuticals," *Journal of Law and Economics*, 31(2), October 1988, pp. 299-320 at 302.

²⁵ From 1993 to May 2018, opioid drug manufacturers made over 10 million detailing visits (see Rosenthal Report, Attachment C).

²⁶ See National Conference of State Legislatures, "Marketing and Advertising of Pharmaceuticals," November 5, 2018, available at <http://www.ncsl.org/research/health/marketing-and-advertising-of-pharmaceuticals.aspx>. Also see Centers for Medicare & Medicaid Services (CMS), Open Payments page, available at <https://www.cms.gov/openpayments/> ("Open Payments is a national disclosure program ... making the financial relationships between applicable manufacturers and group purchasing organizations (GPOs) and health care providers (physicians and teaching hospitals) available to the public.").

²⁷ Perri Report, Section III.C.

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as these prescriptions of opioids are, expansion of demand is not an appropriate use of marketing.²⁸

22. As a result, the ultimate “consumers” of prescription opioids (patients) were not properly informed about the risk of harms associated with prescription opioids because their doctors were systematically misled by manufacturers. Without full knowledge of harms, a consumer cannot take them into account, nor can the consumer weigh the harms and costs relative to any purported benefits. Consumers could not accurately anticipate prescription opioids’ addictive properties because their agents, *i.e.*, physicians, were misled by Defendants.

C. Benefits from Shipments and Positive Externalities

23. A product (like prescription opioids) even while harming users through inappropriate use and harming others by imposing negative externalities, might at the same time confer positive benefits on particular individuals when used in accordance with scientifically acceptable clinical criteria, and furthermore might, in those circumstances, generate positive externalities to others.

24. A comprehensive evaluation of a public nuisance from an economic perspective considers both the positive and negative effects of the potential public nuisance. The empirical framework I apply in this Report recognizes and quantifies not only costs in economic terms, but also the ostensible benefits to both to the user, and to the wider economy, from the use of prescription opioids based on scientifically acceptable clinical criteria. Consideration of both benefits and costs allows for a net accounting in which benefits can be weighed against costs.

²⁸ Perri Report, Section III.

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D. Widespread Negative Externalities to Public Health are Often Addressed by Public Policy

25. The economic characteristics of widespread negative externalities (or public bads) generally mean that to contend with the negative externality, public action is needed. No single individual has the incentives or is in a position to respond forcefully and efficiently to a problem affecting large shares of the population. Collective action, led by government, is needed to effectively address the crisis. In economic terms, collective action is generally necessary when the social harm takes the form of a large-scale negative externality.²⁹

26. There are many examples, within public health, of collective action, led by government, to contend with widespread negative externalities. Outside of the context of the opioid crisis, this includes taxation of goods such as cigarettes and alcohol, bans on use of alcohol and other goods by vulnerable age groups, and bans on consumption in certain locations (*e.g.*, smoking in restaurants or consumption of alcohol in public).

27. I note that not all activities that might lead to a significant imbalance, in economic terms, between overwhelming costs versus benefits are treated under the law as a public nuisance requiring sweeping government intervention to abate its existence. For example, while I have not conducted the analysis, one might surmise that an economic weighing of the benefits versus costs of the prevalence of alcohol use yields an overwhelming net cost to society; yet for myriad reasons, society condones the prevalence of alcohol and, subject to its regulation and appropriate use, selling, buying and consuming alcohol are legal activities.

²⁹ M. Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups*, Harvard University Press, 1965.

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28. For this Report, I have been advised by counsel that the Bellwether Plaintiffs intend to prove that the public nuisance regarding the shipment of prescription opioids arose in substantial part from *the unlawful conduct* by the Defendants. As a result, I understand from counsel that the public nuisance described here does not fall within some area of condoned societal harm. Indeed, even in areas where society tolerates some significant harm from an activity, if the prevalence of that activity is expanded through illegal means, it might give rise to a public nuisance.

29. The opioid crisis itself yields numerous examples of governmental actions required by its existence. I review a few of these examples here from federal activity, but also note that collective action has been led by government at the state and local level as well.³⁰ My examples do not constitute a comprehensive list of government policy responses.

30. The executive branch of the federal government has taken action, under both the current and the previous administration, to address the opioid crisis. In March 2015, the now former Secretary of HHS (U.S. Department of Health and Human Services), Sylvia Burwell,

³⁰ According to the National Center for State Courts (NCSC), "State legislatures have been active in developing and enacting a broad range of statutory responses to the opioid crisis," (<https://www.ncsc.org/Topics/Court-Management/Leadership-and-Change-Management/Opioids-and-the-Courts.aspx>). For example, according to the Centers for Disease Control and Prevention (CDC), "In 2011 and 2012 respectively, Ohio and Kentucky mandated clinicians to review prescription drug monitoring program (PDMP) data and implemented pain clinic regulation. In these states, MME [morphine milligram equivalent] per capita decreased in 85% and 62% of counties, respectively, from 2010 to 2015," available at CDC, Opioid Overdose (available at <https://www.cdc.gov/drugoverdose/policy/successes.html>). For another example, in Ohio, Summit County and the City of Akron have implemented community outreach programs directed at suspected opioid addicts (see G. Mace, "Cuyahoga Falls police, fire join with drug counselors to visit homes of addicts to offer help," *Akron Beacon Journal*, January 14, 2017; P. Schleis, "Stow is the Latest Community to Form Quick Response Team to Get Help to Opiate Addicts," *Akron Beacon Journal*, February 15, 2017 and D. Livingston, "Akron adopts quick response team to curb future drug overdoses," *Akron Beacon Journal*, February 28, 2017). In Cuyahoga County the Drug Court Program was started in 2009 to divert convicted drug addicts from jail to treatment (see Cuyahoga County Opiate Task Force Report, 2014, available at http://opiatecollaborative.cuyahogacounty.us/pdf_OpiateCollaborative/en-US/CC_OpiateTaskForceReport.pdf).

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launched the HHS Opioid Initiative.³¹ The initiative focused on “three priority areas:” improving opioid prescribing practices, expanding the use of naloxone to prevent opioid overdoses, and expanding access to medication-assisted treatment (MAT) to treat opioid use disorders.³² As part of the Opioid Initiative, the Centers for Disease Control and Prevention (CDC) expanded its new Prescription Drug Overdose Prevention for States program. This program’s primary goal was to provide funding to states to enhance their Prescription Drug Monitoring Programs (PDMPs), statewide electronic databases for tracking prescriptions of opioids and other controlled substances.³³

31. In support of improving prescription practices, the CDC published new opioid prescribing guidelines for primary care clinicians in 2016.³⁴ In support of expanding the use of naloxone, the initiative promoted states’ use of block grants from the Substance Abuse and Mental Health Services Administration (SAMHSA) for purchasing naloxone.³⁵ In support of expanding access to MAT, the Health Resources and Services Administration granted nearly \$100 million to Community Health Centers to expand substance use disorder treatment

³¹ U.S. Department of Health and Human Services (HHS), “HHS takes strong steps to address opioid-drug related overdose, death and dependence, March 26, 2015,” available at <http://wayback.archive-it.org/3926/20170128023910/https://www.hhs.gov/about/news/2015/03/26/hhs-takes-strong-steps-to-address-opioid-drug-related-overdose-death-and-dependence.html>.

³² HHS; Office of the Assistant Secretary for Planning and Evaluation (ASPE), “Opioid Abuse in the U.S. and HHS Actions to Address Opioid-Drug Related Overdoses and Deaths,” March 26, 2015, available at https://aspe.hhs.gov/system/files/pdf/107956/ib_OpioidInitiative.pdf.

³³ CDC, Prescription Drug Overdose: Prevention for States, CDC-RFA-CE15-1501, May 27, 2015, available at <https://www.grants.gov/view-opportunity.html?oppld=274995> and CDC, Prevention for States, October 23, 2017, available at https://www.cdc.gov/drugoverdose/states/state_prevention.html. See also HHS, March 26, 2015, *op. cit.*

³⁴ D. Dowell, T.M. Haegerich and R. Chou, “CDC Guideline for Prescribing Opioids for Chronic Pain – United States,” *JAMA*, 2016, 315(15), pp.1624-1645.

³⁵ HHS, March 26, 2015, *op. cit.*

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services, including MAT, and SAMHSA awarded grant funding to states to expand MAT services.³⁶

32. HHS also took action under the Trump administration to combat the opioid epidemic, introducing its Five-Point Opioid Strategy in April 2017.³⁷ The primary goals of this strategy included: 1) improving access to prevention, treatment, and recovery services; 2) improving public health data reporting; 3) improving treatment practices for pain management; 4) better targeting naloxone and other overdose reversing drugs availability; and 5) new research on pain and addiction. As part of this strategy, the National Institutes of Health (NIH) launched the Helping to End Addiction Long-Term (HEAL) Initiative in 2018 to speed development of non-addictive pain treatments and improve prevention and treatment for opioid addiction.³⁸

33. In October 2017, Eric Hargan, the Acting Secretary of HHS, declared a public health emergency in response to the opioid crisis.³⁹ The public health emergency, more limited than a national state of emergency, grants the federal government some additional flexibility in

³⁶ Office of the Press Secretary, The White House, "Fact Sheet: Obama Administration Announces Additional Actions to Address the Prescription Opioid Abuse and Heroin Epidemic," March 29, 2016, available at <https://obamawhitehouse.archives.gov/the-press-office/2016/03/29/fact-sheet-obama-administration-announces-additional-actions-address>. Also see HHS, 2015, *op. cit.*

³⁷ HHS, "Acting Secretary Declares Public Health Emergency to Address National Opioid Crisis," October 26, 2017, available at <https://www.hhs.gov/about/news/2017/10/26/hhs-acting-secretary-declares-public-health-emergency-address-national-opioid-crisis.html> and HHS, "5-Point Strategy to Combat the Opioid Crisis," August 7, 2018, available at <https://www.hhs.gov/opioids/about-the-epidemic/hhs-response/index.html>.

³⁸ National Institutes of Health (NIH), "NIH HEAL Initiative: Enhance Pain Management," December 28, 2018, available at <https://www.nih.gov/research-training/medical-research-initiatives/heal-initiative/enhance-pain-management>.

³⁹ HHS, October 26, 2017, *op. cit.* Also see J. Johnson and J. Wagner, "Trump declares the opioid crisis a public health emergency," *The Washington Post*, October 26, 2017, available at https://www.washingtonpost.com/news/post-politics/wp/2017/10/26/trump-plans-to-declare-the-opioid-crisis-a-public-health-emergency/?utm_term=.9097d816a96b.

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responding to the crisis, including waiving some regulations and allowing states to use federal grant funds to combat opioid abuse.

34. The legislative branch of the federal government has also initiated action in response to the opioid crisis. In addition to including \$1 billion in funding to combat the opioid epidemic as part of the 21st Century Cures Act in 2016,⁴⁰ Congress has passed two pieces of legislation: the Comprehensive Addiction and Recovery Act of 2016 and the Substance Use Disorder Prevention that Promotes Opioid Recovery and Treatment (SUPPORT) for Patients and Communities Act of 2018.⁴¹

35. The Comprehensive Addiction and Recovery Act, signed into law by President Obama in 2016, addressed the opioid epidemic in several ways. Among a host of other measures, it created grant programs to improve naloxone availability; expanded access to evidence-based treatment, including MAT; and reauthorized grant programs for states to implement and expand prescription drug monitoring.⁴²

36. The SUPPORT for Patients and Communities Act passed in 2018 with broad bipartisan support. Some key provisions of the legislation included promoting more rapid development of

⁴⁰ See SAMHSA, "HHS, SAMHSA to maintain funding formula for \$1B opioid grant program," October 30, 2017, available at <https://www.samhsa.gov/newsroom/press-announcements/201710300530>.

⁴¹ C. Reilly, "President Obama Signs Bipartisan Bill to Combat Opioid Epidemic," *Pew Charitable Trusts*, July 22, 2016, available at <https://www.pewtrusts.org/en/research-and-analysis/articles/2016/07/22/president-obama-signs-bipartisan-bill-to-combat-opioid-epidemic>. Also see M. Vazquez, "Trump signs opioids law at White House event," *CNN*, October 24, 2018, available at <https://www.cnn.com/2018/10/24/politics/donald-trump-opioid-crisis-one-year-later-event/index.html>; C. Thompson, "Trump Signs Legislation to Combat Opioid Crisis", *ASHP*, October 25, 2018, available at <https://www.ashp.org/news/2018/10/24/trump-signs-legislation-to-combat-opioid-crisis>.

⁴² C. Reilly, *op. cit.* Also see G. Lopez, "Congress just passed a big bill to fight the opioid epidemic. But there's a catch," *Vox*, July 14, 2016, available at <https://www.vox.com/2016/7/6/12101476/obama-congress-opioids-heroin>.

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non-addictive drugs for pain management, improving PDMPs, and improving coordination across federal agencies to prevent illicit substances like fentanyl from entering the United States.⁴³ The legislation also had broad implications for Medicaid; in particular, it amended the “long-standing prohibition against the use of federal Medicaid funds for services in Institutions for Mental Diseases (IMDs) for nonelderly adults,” allowing Medicaid programs to cover these services for up to 30 days per year for individuals with substance use disorder until September 2023.⁴⁴

37. In addition, as referenced in the expert report of Professor Jonathan Gruber, as early as 2007, law enforcement officials brought actions claiming that manufacturers misrepresented the addictive properties of opioids and that distributors failed to meet their obligations to monitor and report suspicious patterns of shipments.⁴⁵ These actions led to substantial settlements, including payments made by (i) Purdue related to criminal and civil charges for misbranding OxyContin with the intent to defraud and mislead the public about its addictive qualities⁴⁶ (which also led to three executives at Purdue pleading guilty to misbranding⁴⁷); (ii)

⁴³ M. Vazquez, *op. cit.* Also see, U.S. Senate Committee on Health, Education, Labor and Pensions, “Chairman Alexander: This Congress, HELP Committee Produced 18 Laws Including ‘Landmark’ Opioid Legislation to Combat Nation’s Most Pressing Public Health Crisis.” December 20, 2018, available at <https://www.help.senate.gov/chair/newsroom/press/chairman-alexander-this-congress-help-committee-produced-18-laws-including-landmark-opioid-legislation-to-combat-nations-most-pressing-public-health-crisis->.

⁴⁴ M. Musumeci and J. Tolbert, “Federal Legislation to Address the Opioid Crisis: Medicaid Provisions in the SUPPORT Act,” Kaiser Family Foundation; October 5, 2018, available at <https://www.kff.org/medicaid/issue-brief/federal-legislation-to-address-the-opioid-crisis-medicare-provisions-in-the-support-act/>.

⁴⁵ Gruber Report, ¶ 44.

⁴⁶ B. Meier, “In Guilty Plea, OxyContin Maker to Pay \$600 Million,” *The New York Times*, May 10, 2007.

⁴⁷ H. Won Tesoriero, “OxyContin Maker Pleads Guilty – Purdue Frederick to Pay \$634.5 Million Settlement for Hiding Addiction Risk,” *The Wall Street Journal*, May 11, 2007.

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McKesson related to allegations that it violated federal reporting provisions for its handling of certain prescription medications regulated by the Drug Enforcement Administration (DEA), and for failing to report excessive sales of their products to pharmacies filling illegal online prescriptions⁴⁸; and (iii) Cardinal Health related to its failures to report suspicious sales and orders of controlled substances to the DEA.⁴⁹ More recently, Mallinckrodt also paid a substantial settlement to the Department of Justice for, among other things, its failure to report suspicious sales and orders of controlled substances to the DEA.⁵⁰

III. Shipments of Prescriptions Constituted a Public Nuisance to the Bellwether Communities

A. Introduction

38. To address this portion of my assignment, I consider elements of the definition of a public nuisance contained above (¶¶ 7-8), and establish three conclusions:

1. Shipments significantly interfered with public health, safety, peace and comfort of members of the Bellwether communities with continuing and long-lasting effects;
2. The interference from shipments was unreasonable; and
3. Defendants were or should have been aware of the interference.

⁴⁸ Department of Justice (DOJ), Press Release, “McKesson Corporation Agrees to Pay More than \$13 Million to Settle Claims that it Failed to Report Suspicious Sales of Prescription Medications,” May 2, 2008, available at <https://www.justice.gov/archive/opa/pr/2008/May/08-opa-374.html>.

⁴⁹ The United States Attorney’s Office, Colorado, “Cardinal Health Inc., Agrees to Pay \$34 Million to Settle Claims That it Failed to Report Suspicious Sales of Widely-Abused Controlled Substances,” October 2, 2008, available at https://www.justice.gov/archive/usao/co/news/2008/October08/10_2_08.html.

⁵⁰ DOJ, Press Release, “Mallinckrodt Agrees to Pay Record \$35 Million Settlement for Failure to Report Suspicious Orders of Pharmaceutical Drugs and for Recordkeeping Violations,” July 11, 2017, available at <https://www.justice.gov/opa/pr/mallinckrodt-agrees-pay-record-35-million-settlement-failure-report-suspicious-orders>

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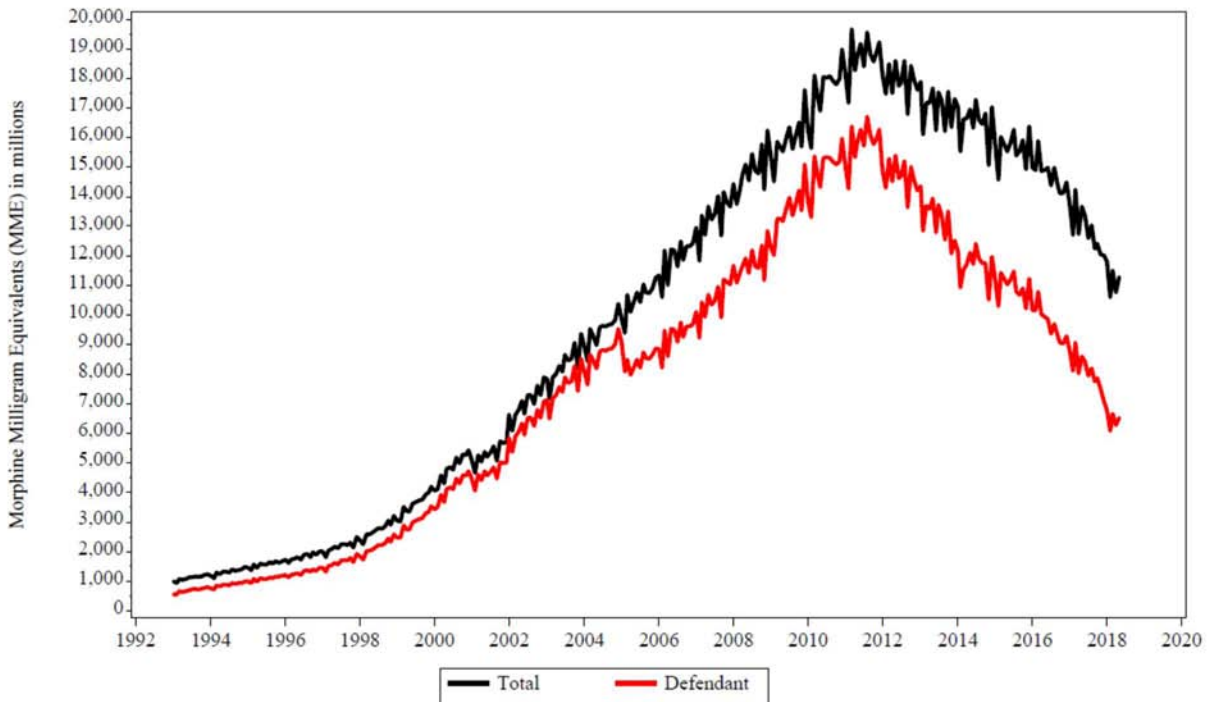
39. Before proceeding, it will be useful to briefly identify the Defendants' drugs at issue in this matter. The drugs in the case are Schedule 2 opioids, excluding injectables and all buprenorphine drugs except Butrans,⁵¹ manufactured and distributed by the Defendants. The Defendants account for the vast majority of these Schedule 2 drugs as illustrated in Figure 1 below.⁵² I understand from counsel that a showing that the majority of these drugs are at issue in this litigation is important because it is evidence relevant to the fact-finder's determination that the Defendants' conduct was a substantial contributing factor in creating the nuisance. As a reminder, the harms I attribute to shipments of prescription opioids includes harms due to the subsequent use of other opioids (*e.g.*, heroin, fentanyl) caused by the shipments.

⁵¹ Butrans is a Schedule 3 drug.

⁵² Figure 1 is reproduced from Rosenthal Report, Attachment C. These data are based on IQVIA National Prescription Audit (NPA) retail sales of extended units (*e.g.*, number of pills) of Schedule 2 drugs (plus Butrans) by manufacturers by month. The MME for a pill of each drug is computed based on an MME conversion factor obtained from the CDC times the milligram strength of the pill. I understand that Information on the Defendant status for each manufacturer was provided by counsel.

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Figure 1
Defendants' Shipments and Total Shipments
[Source: Rosenthal Report, Attachment C]



B. Shipments Interfered with Public Health, Safety, Peace and Comfort of Members of the Bellwether Communities with Continuing and Long-Lasting Effects

40. The most obvious and consequential negative impact of opioid shipments is death. As discussed by Professor Gruber, more than 47,000 Americans died from an opioid overdose in 2017, a death toll greater than deaths due to guns or to H.I.V. at the peak of its epidemic.⁵³ The opioid crisis has hit the Bellwether counties particularly hard. Professor Gruber notes that between 2010 and 2016, the opioid mortality rate in Cuyahoga County increased by 280 percent and in Summit County increased by 362 percent, compared to the overall U.S. large

⁵³ Gruber Report ¶ 7.

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county opioid mortality rate of 88 percent.⁵⁴ Both Summit and Cuyahoga counties were among the top 7 percent of U.S. counties in terms of opioid mortality rates in 2016.⁵⁵

41. Figure 2 (Figure I.10 from the Gruber Report) shows the rates of shipments of prescription opioids (measured in MMEs per capita per day) in the Bellwether counties. The magnitude and shape of the curves for the Bellwethers showing rates over 2006-2016 are similar to the national trends, all peaking in 2010/11. Figure 3 (Figure I.11 from the Gruber Report) graphs opioid mortality rates for the Bellwether counties and the national average for large counties.⁵⁶ Up until the turning point of 2010/11 in the rate of shipments, the death rates nationally for large counties and in the Bellwethers were similar and growing only slowly. After 2010, however, death rates escalated dramatically in both Cuyahoga and Summit counties, vastly outpacing national increases for large counties.

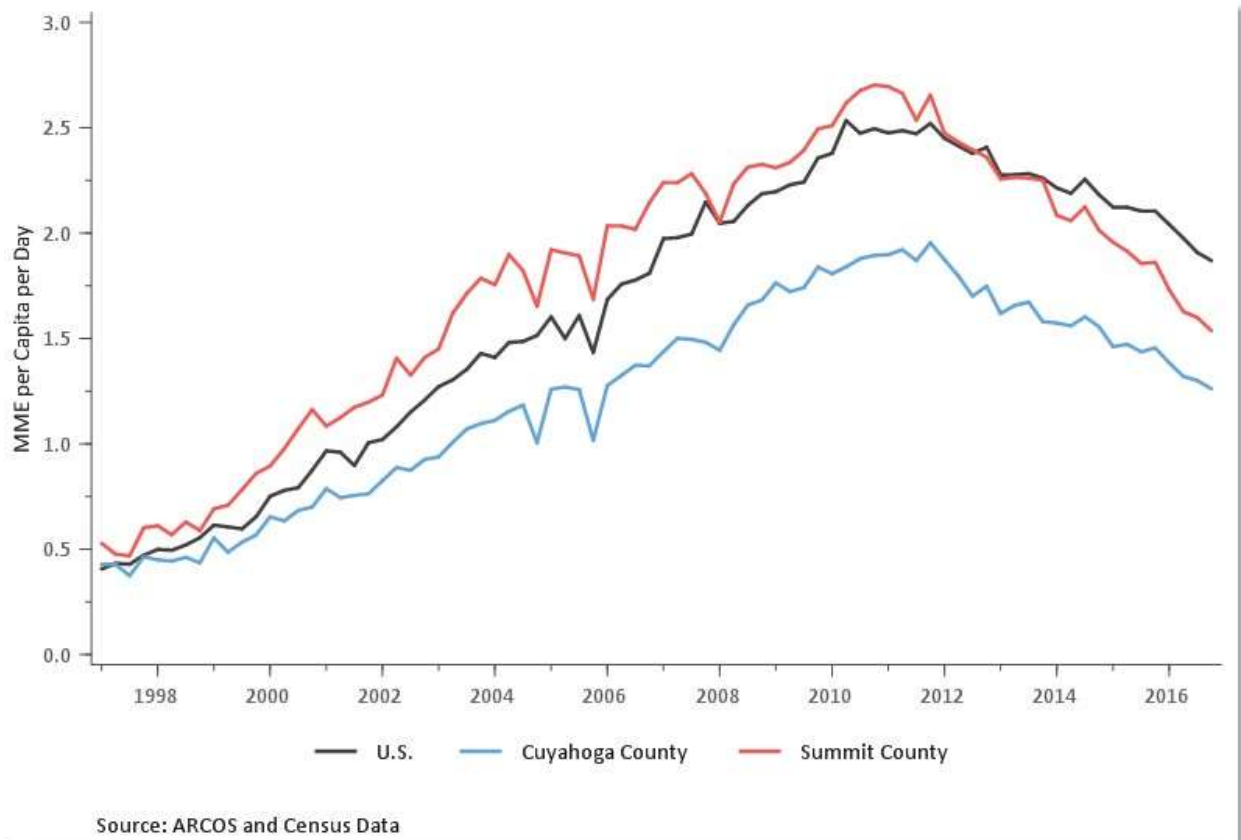
⁵⁴ Gruber Report, ¶ 65.

⁵⁵ Gruber Report, ¶ 65.

⁵⁶ The Gruber Report indicates at ¶ 36 that large counties are those with a population greater than 100,000. He notes at his footnote 48 that “The simple correlation between the national opioid-related mortality rate and the total rate in the large county sample is 0.996.”

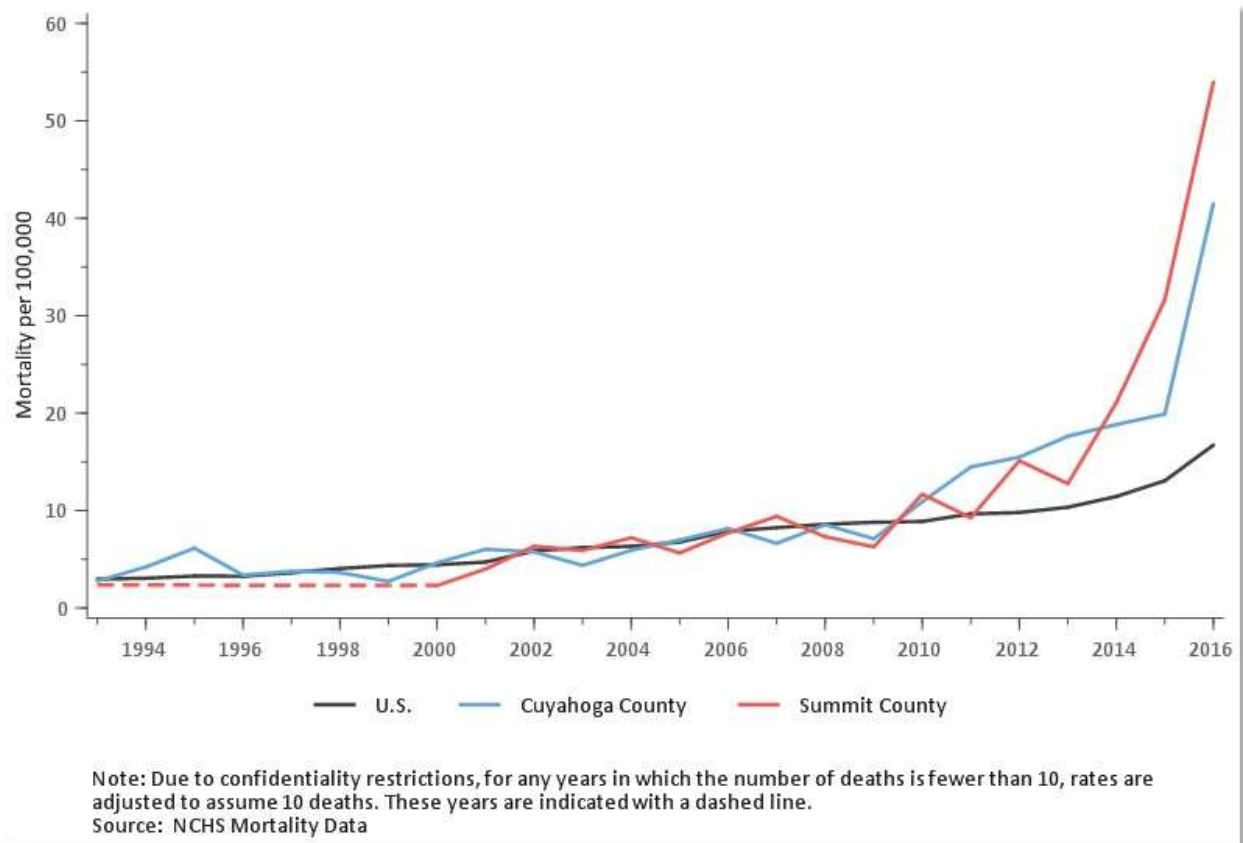
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Figure 2
Shipments of Prescription Opioids: 1997-2016
Bellwether Counties and U.S. Total
[Source: Gruber Report, Figure I.10]



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Figure 3
Opioid Mortality Rates: Bellwether Counties v. U.S. Large Counties
 [Source: Gruber Report, Figure I.11]



42. Death is not the only negative impact. Professor Cutler empirically assesses the impact of shipments of prescription opioids on three forms of harms: on the rates of mortality, on the rates of crime, and on the number of children needing foster care placement in the Bellwether communities. In this Report, I broaden the scope of harms to children by quantifying child maltreatment (only some of which results in foster care). I also add tallies of the rates of morbidity and of neonatal abstinence syndrome (NAS). I then use the magnitude of these five harms (mortality, morbidity, crime, child maltreatment and NAS) to establish the existence of

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significant long-term negative effects of shipments on the public health, safety and peace of members of the Bellwether communities.⁵⁷ Later, in Section IV of this Report, I value these harms in dollars.⁵⁸ These five are not the only forms of harm associated with shipments; these five are, however, sufficient in my view to establish the existence of widespread and ongoing interference to public health and welfare from the Defendants' opioid shipments. In the remainder of this section, I discuss my methods for quantifying the five harms on which I focus in this Report.

Mortality

43. Professor Cutler applied two empirical approaches to estimate the opioid-related mortality attributable to opioid shipments. His Approach 1 uses the results of a "direct" regression model that estimates the relationship between changes in opioid-related mortality and shipments of prescription opioids between 1995-2010, while controlling for other key variables likely to explain the growth in mortality over that time period. He uses this regression model to estimate the share of mortality attributable to shipments for all opioids through 2010 and the share of mortality attributable to prescription opioids only for 2011-2016. This is combined with an "indirect" regression model that estimates the illicit opioid mortality that is

⁵⁷ Professor Cutler estimated the share of studied harms due to Defendants' misconduct by multiplying Professor Rosenthal's estimated share of shipments due to misconduct by his own estimate of the share of harms due to shipments. In this Report, I assess the external costs associated with prescription shipments without regard as to whether they were due to Defendants' misconduct. I thus use the share of harms due to shipments without multiplying by Professor Rosenthal's estimate of the share of shipments due to misconduct.

⁵⁸ Professor Cutler was concerned with the impact of prescription opioid shipments on Bellwether governments, so therefore did not address some harmful effects of these shipments, such as mortality costs not falling on Bellwether governments, the cost of crime to victims, lost productivity, and other categories of harm that will be considered here.

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attributable to shipments from 2011 through 2016. This second regression model estimates the relationship between illicit opioid mortality and the economic and demographic characteristics of counties over the 2008-2010 period, yielding an estimate of illicit opioid mortality rates for 2011-2016 that would have been expected to prevail in the absence of the reformulation of OxyContin and the reduction in opioid shipments. Combining these two regression models gives Professor Cutler the full effect of shipments on mortality due to licit and illicit opioids over the full time period, 1995 through 2016.⁵⁹

44. His Approach 2 calculates the share of opioid mortality due to shipments based on an indirect regression model that estimates the relationship between opioid mortality and the economic and demographic characteristics of counties similar to Cuyahoga and Summit over the 1993 to 1995 period. This analysis is based on the period before the launch of OxyContin and the subsequent acceleration in the growth of prescription opioid shipments, and thus yields estimates of opioid mortality rates that would have been expected to prevail in the absence of these events. Professor Cutler uses this method to calculate a second estimate of the percent of opioid mortality that is attributable to shipments for 2006 through 2016.⁶⁰

45. Professor Cutler's Approach 1 and Approach 2 lead to broadly similar quantitative estimates of the effect of shipments on mortality. In the text of this Report, I focus on Professor Cutler's results from his Approach 1 which yields more conservative calculations as inputs for my analysis. This choice is not meant as a comment on the appropriateness of

⁵⁹ For more details on Professor Cutler's Approach 1, see Cutler Report, Section VI.A.

⁶⁰ For more details on Professor Cutler's Approach 2 see Cutler Report, Section VI.B. Also see Cutler Report, Appendix III.I, Tables I.4 and I.5 for Professor Cutler's estimates of harms attributable to all shipments.

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Approach 1 over Approach 2 but is simply done for ease of discussion in the text of this Report.

Although the dollar amounts attributable to my conclusions of the public nuisance calculations undertaken here change depending on which of the approaches I use, my other conclusions do not change based on the approach chosen. For completeness, I repeat my analysis presented in the body of this Report, in Appendix I, using Approach 2.

46. I apply Professor Cutler's estimates of the share of opioid-related mortality due to shipments to the death rate in each county in each year to determine the absolute numbers of deaths each year attributable to shipments in Cuyahoga and Summit counties.⁶¹ Over the entire 11-year period from 2006-2016, 2,158 deaths in the Bellwether counties can be attributed to opioid shipments.⁶² I emphasize that these are not just opioid-related deaths; these are, based on Professor Cutler's findings, opioid-related deaths *attributable to Defendants' shipments* of prescription opioids.

47. These shipment-related deaths can be put in perspective by comparing them to the number of deaths from firearms in each year in each county.⁶³ In broad terms, the number of

⁶¹ Mortality data are based on the Multiple Cause of Death (MCOd) files published by the National Center for Health Statistics (NCHS), part of the Centers for Disease Control and Prevention (CDC). See <https://www.cdc.gov/nchs/index.htm>. These data are generated from death certificates and report mortality by cause of death and by county of residence. A single death may have multiple causes. Opioid overdose deaths have an underlying cause of death code related to drug poisoning and one or more additional codes related to opioids. Because some overdose fatalities fail to identify the underlying drug associated with the death, these numbers are conservative. Note that in the Cutler Report, these numbers are adjusted by following the procedures outlined in Ruhm (2018) to allocate these unidentified drug overdoses as either opioid-related or non-opioid related (See C.J. Ruhm, "Corrected US Opioid-Involved Drug Poisoning Deaths and Mortality Rates, 1999–2015," *Addiction*, 113, 2018, pp. 1339-1344).

⁶² See Tables 5a and 5b in Section IV of this Report for a summary by year of deaths due to prescription opioid shipments. See Appendix C for a discussion of the data sources and calculation methods.

⁶³ Firearm-related deaths are downloaded from CDC's Wonder data tool and are based on the same underlying MCOd data as opioid mortality. Cause of death codes to identify firearm-related deaths are based on Xu *et al.* (2018) (J. Xu, *et al.*, "Deaths: Final Data for 2016," *National Vital Statistics Reports*, 67(5), July 26, 2018).

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people killed by opioid shipments over this period was roughly the same as those killed by guns.⁶⁴ By 2016, however, shipments were killing over twice as many people as guns in Cuyahoga County and more than three times as many people as guns in Summit County.⁶⁵

Morbidity

48. In addition to the public harms from deaths due to opioid shipments, harms result from opioid-related morbidity. Morbidity simply means to have a disease or be in ill health. Opioid use disorder (OUD) is a substance use disorder that is diagnosed by health care providers using specific assessment criteria from the Diagnostic and Statistical Manual of Mental Health Disorders.⁶⁶ Individuals with OUD are at a high risk of death. OUD is a chronic disease, meaning once ill with OUD, a person may remain ill for years.⁶⁷ According to the CDC, there were 2.1 million Americans with OUD as of 2016.⁶⁸ The disorder is defined as a “problematic pattern of opioid use leading to clinically significant impairment or distress,”⁶⁹ and is diagnosed

⁶⁴ There were 1,772 deaths due to firearms in Cuyahoga County from 2006 through 2016 and 2,114 deaths due to opioid shipments. In Summit County, there were 604 deaths due to firearms and 804 deaths due to opioid shipments. See Centers for Disease Control and Prevention (CDC), Wonder data for data on deaths by firearms by County (available at <https://wonder.cdc.gov/controller/datarequest/D77>).

⁶⁵ *Ibid.*, In 2016 there were 235 firearm deaths in Cuyahoga County and 68 in Summit County compared to 504 deaths due to opioid shipments in Cuyahoga County and 269 in Summit County.

⁶⁶ Substance-Related and Addictive Disorders in: American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition, DSM Library. Arlington, VA, 2013.

⁶⁷ National Institute on Drug Abuse, Addiction is a Chronic Disease, available at <https://archives.drugabuse.gov/publications/drug-abuse-addiction-one-americas-most-challenging-public-health-problems/addiction-chronic-disease>.

⁶⁸ CDC, Module 5: Assessing and Addressing Opioid Use Disorder (OUD), available at <https://www.cdc.gov/drugoverdose/training/oud/accessible/index.html>.

⁶⁹ Substance-Related and Addictive Disorders, *op. cit.*

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by evaluating patients for at least two of 11 clinical symptoms within a 12-month period.⁷⁰

“OUD exists on a continuum of severity ... based upon the number of criteria that have been met.”⁷¹

49. Determining the morbidity in the Bellwether counties due to shipments of prescription opioids proceeds in two steps. I first estimate the overall prevalence of OUD in the Bellwether counties for 2006 through 2016, and second, I estimate the share of this morbidity attributable to shipments. The product of these two yields the number of OUD cases in each county for each year attributable to shipments.

50. For the first of these two steps, I begin with data from the National Survey on Drug Use and Health (NSDUH). I summarize how these data are used and adjusted, and provide a detailed description of data and methods to estimate morbidity rates in Appendix D. Based on the adjusted prevalence rates, I estimate number of persons in each year with OUD based on each of the Bellwether county populations. Tables 7a and 7b in Section IV below report the prevalence of disease in each year.

51. In the second step needed to estimate disease prevalence due to shipments, I rely on Professor Cutler’s finding about the share of opioid-related *mortality* attributable to shipments

⁷⁰ Examples of these symptoms include taking opioids in larger amounts or over a longer time period than was intended, being unsuccessful in efforts to reduce or control opioid use and having cravings or strong urges to use opioids. For all twelve symptoms, see CDC, Module 5: Assessing and Addressing Opioid Use Disorder (OUD), available at <https://www.cdc.gov/drugoverdose/training/oud/accessible/index.html>.

⁷¹ *Ibid.* The previous edition of the Diagnostic and Statistical Manual from 1994 did not include opioid use disorder as a diagnosis; rather, it contained two separate diagnoses, opioid dependence and opioid abuse. *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. Washington, DC: American Psychiatric Association; 1994. These were combined into a single disorder in 2013. D.S. Hasin, *et al.*, DSM-5 criteria for substance use disorders: recommendations and rationale, *American Journal of Psychiatry*, 2013, 170(8), pp. 834-851.

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and assume that the same share applies to *morbidity*.⁷² These shares are shown in Tables 7a and 7b (and are the same as the shares I use in the mortality analysis). Multiplying the number of persons with OUD in each year by the share attributable to shipments provides the absolute number of people in each county with disease attributable to shipments in each year. As identified in Tables 7a and 7b below in Section IV, over the 11-year period from 2006-2016, there were approximately 109 thousand person-years of opioid-related morbidity due to shipments in Cuyahoga County and approximately 46 thousand person-years of opioid-related morbidity due to shipments in Summit County.

Babies born with neonatal abstinence syndrome

52. Neonatal abstinence syndrome (NAS), also termed neonatal withdrawal,⁷³ is a constellation of conditions associated with *in utero* exposure to opioids.⁷⁴ It can occur due to any regular antenatal opioid use, including both illicit and prescribed.⁷⁵ The syndrome is a rapidly growing public health problem, with the incidence of NAS increasing nearly fivefold between 2000-2012, corresponding with a rise in opioid use and abuse.⁷⁶ Babies born with NAS

⁷² Professor Cutler states in his report that “opioid-related mortality is used as a proxy for opioid-related harms” (¶ 27). He explains why mortality is a good proxy for harms in his ¶48.

⁷³ K. McQueen and J. Murphy-Oikonen, “Neonatal abstinence syndrome,” *New England Journal of Medicine*, 2016, 375(25), pp. 2468-2479.

⁷⁴ H. Uebel, *et al.*, “Reasons for Rehospitalization in Children who had Neonatal Abstinence Syndrome,” *Pediatrics*, 2015, 136(4), e811-e820.

⁷⁵ S. Wong, *et al.*, “Substance use in pregnancy,” *Journal of Obstetrics and Gynaecology Canada*, 2011, 33(4), pp. 367-384.

⁷⁶ S.W. Patrick, *et al.*, “Neonatal abstinence syndrome and associated health care expenditures: United States, 2000-2009,” *JAMA*, 2012, 307(18), pp. 1934-1940; S.W. Patrick, *et al.*, “Increasing incidence and geographic distribution of neonatal abstinence syndrome: United States 2009 to 2012,” *Journal of Perinatology*, August 2015, 35(8), pp. 650-655.

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may exhibit a host of symptoms, including respiratory distress; central nervous-system symptoms, like tremors and seizure; and gastrointestinal problems, such as poor feeding and vomiting.⁷⁷ The onset of symptoms typically occurs within the first few days following birth, but timing may vary due to a variety of factors, including the half-life of the specific opiate used.⁷⁸

In this section, I describe the methodology for estimating the number of NAS cases in the Bellwether counties attributable to opioid shipments.

53. According to the Ohio Department of Health, virtually all cases of NAS are due to opioids.⁷⁹ I use publicly available on the number of NAS cases by county of residence within Ohio over the period from 2006-2016 (see Appendix E for details). Tables 8a and 8b in Section IV below report the number of NAS cases for each year between 2006-2016. I then multiply these estimates by Professor Cutler's estimates of the share of harm attributable to shipments to arrive at a number of opioid-related NAS cases *attributable to the shipments*. As reported in Tables 8a and 8b, between 2006-2016, I estimate that there were 609 cases of opioid-related NAS attributable to shipments in Cuyahoga County, and 430 cases attributable to shipments in

⁷⁷ Wong et al., op. cit.

⁷⁸ Wong et al., op. cit.

⁷⁹ See Ohio Department of Health, "Neonatal Abstinence Syndrome (NAS) Hospital Reporting in Ohio, July 2, 2018, available at https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/violence-injury-prevention-program/resources/nas_hospital_reporting_in_ohio. Also see "2017 Ohio Neonatal Abstinence Syndrome County Report," available at https://odh.ohio.gov/wps/wcm/connect/gov/4cad708c-ba99-4b8b-b425-01cfef119c5d/2017+NAS+County+Table+12.3.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGK0N0JO00QO9DDDDM3000-4cad708c-ba99-4b8b-b425-01cfef119c5d-muueFzr.

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Summit County.

Crime

54. The opioid crisis could increase the number of crimes committed in the Bellwether communities in several ways. For example, the sale of illegal opioids (*e.g.*, heroin) for any use or prescription opioids (*e.g.*, OxyContin) for illicit use is a crime. Additionally, people misusing opioids may commit crimes, such as property theft, to obtain money to buy opioids or their drug use may lead to other crimes, such as assault.

55. Appendix F contains the details on how I estimate the number of crimes due to opioid shipments and the economic costs of those crimes. In sum, I start with a count of the total number of crimes in different categories, (*e.g.*, motor vehicle theft, prostitution, vandalism) committed within the Bellwether communities. Counts of incidents within each Bellwether community come from the National Incident-Based Reporting System (NIBRS) maintained by the FBI. NIBRS data are a standard source used to measure criminal offenses by criminal category for all law enforcement agencies (LEAs) that report into NIBRS. Not all LEAs report their data to the NIBRS.⁸⁰ I then apply methods from Professor Cutler's report to determine the share of these crimes attributable to shipments. As described in his Section IV.A and summarized in my Appendix F, Professor Cutler uses data from a number of sources to make this attribution.

⁸⁰ The Bureau of Justice Statistics reported that, "In 2012 NIBRS-contributing agencies served approximately 30 percent of the U.S. population and accounted for 28 percent of all crime reported to the UCR [Uniform Crime Reporting] Program." See Bureau of Justice Statistics, Data Collection: National Incident-Based Reporting System (NIBRS), available at <https://www.bjs.gov/index.cfm?ty=dcdetail&iid=301>.

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56. Tables 9a and 9b in Section IV below summarize results for the two counties, showing the impact in terms of incidents of crime on each community for each year, 2006 – 2016. Over the time period from 2006-2016, there were over almost 44 thousand crimes in Cuyahoga County and almost 21 thousand in Summit County due to shipments. These numbers are conservative given the reporting limitations in the NIBRS identified above.

Child maltreatment

57. Substance abuse, including opioid abuse, is a major cause of child maltreatment.⁸¹ According to the U.S. Department of Health and Human Services (2019), nearly 700,000 children are subject to maltreatment (includes abuse and neglect) each year in the U.S., with the majority of cases involving neglect (74.9%).⁸² In Ohio in 2017, 24,897 cases of maltreatment were substantiated or indicated; of these, more than half involved a caregiver with a substance use risk factor.⁸³

58. I rely on Dr. Young for the number of unique children subject to maltreatment in the Bellwether counties.⁸⁴ I use data from the Cutler Report to estimate the share of maltreated

⁸¹ See U.S. Department of Health & Human Services, Administration for Children and Families, Administration on Children, Youth and Families, Children's Bureau, "Child Maltreatment 2017," 2019, available at <https://www.acf.hhs.gov/sites/default/files/cb/cm2017.pdf>; O. Mowbray, *et al.*, "Longitudinal Trends in Substance Use and Mental Health Service Needs in Child Welfare," *Children and Youth Services Review*, 73, 2017, pp. 1-8..

⁸² *Ibid.*, p. ii; J.J. Doyle and A. Aizer, "Economics of Child Protection: Maltreatment, Foster Care, and Intimate Partner Violence," *Annual Review of Economics*, 2018, 10, pp. 87-108.

⁸³ Broken down by type of maltreatment (categories not mutually exclusive): neglect: 11,212; medical neglect: 493; physical abuse: 11,892; psychological maltreatment: 914; sexual abuse: 4,339. See U.S. Dep. Health Hum. Serv. 2019. This is likely to be an underestimate, since it relies on reports to Child Protective Services agencies. Victimization surveys and other sources report higher rates of maltreatment. See F. Wulczyn, "Epidemiological Perspectives on Maltreatment Prevention," *The Future of Children*, Fall 2009, 19(2), pp. 39-66; and Doyle & Aizer *op. cit.*

⁸⁴ See Young Report, Graphics 12 and 13.

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children due to opioids. I then apply Professor Cutler's estimate of the share of opioid-related harms due to shipments to obtain estimates of the number of children maltreated due to shipments. These results are reported in Tables 10a and 10b in Section IV for Cuyahoga and Summit Counties, respectively. Over the period 2006-2016, shipments of prescription opioids caused 1,391 cases of maltreatment in Cuyahoga County and 1,031 cases of maltreatment in Summit County. Appendix G contains details of the calculations.

Summary

59. Harms *caused by shipments of prescription opioids* to the Bellwether communities over 2006 - 2016 quantified in this section are summarized in Table 2.⁸⁵

Table 2
Summary of Harms Due to Opioid Shipments
2006-2016

Harm	Cuyahoga	Summit
Excess deaths	1,535	623
Excess morbidity	108,515	46,183
Excess neonatal abstinence syndrome	609	430
Excess crimes	43,957	20,779
Excess child maltreatment	1,391	1,031

Sources: Tables 5a, 5b, 7a, 7b, 8a, 8b, 9a, 9b, 10a and 10b of this Report.

⁸⁵ Note that this is not an exhaustive list of harms.

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60. I conclude that shipments of prescription opioids significantly interfered with public health, safety, peace and comfort of the members of the Bellwether communities with continuing and long-lasting effects.

C. The Interference from Shipments was Unreasonable

61. I consider the question of whether the shipments of prescription opioids were reasonable or unreasonable from two perspectives. The first perspective considers whether the shipments were reasonable from the standpoint of being used for clinically justified treatment. The second perspective considers whether the shipments were reasonable from the standpoint of economic costs and benefits.

Share of shipments for scientifically acceptable treatment

62. I have been instructed by counsel to assume that the Court will conclude that, under applicable public nuisance law and in the context of a prescription medication, the meaning of “unreasonable” is, in substance, “not justified by clinical need.” In other words, a “reasonable” shipment of opioids would be to treat a patient in accordance with scientifically acceptable medical criteria. Shipments not for such a purpose are not reasonable.

63. Using epidemiological data and medical opinions about scientifically acceptable uses, treatments and dosages for opioids, Professor Rosenthal has calculated a theoretical maximum for quantities of prescription opioids (measured in MMEs) for three patient groups needing treatment for pain.⁸⁶ She cites professional academic articles as well as relying upon Dr. Schumacher and Dr. Parran in her selection of end-of-life cancer patients, trauma patients and

⁸⁶ Rosenthal Report, Section X.

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surgery patients as those patient groups appropriately treated by opioids. Professor Rosenthal also relies on some of the same sources to identify the average dosage level and treatment durations that are appropriate for these patient groups.

64. I have been advised by counsel that Dr. Schumacher will testify that at most, opioids are properly indicated for the short-term treatment of severe acute pain (e.g., trauma or post-surgical pain); end-of-life pain/hospice care; and cancer pain from active malignant disease. Chronic opioid therapy is not recommended for most common chronic pain conditions, including low back pain, centralized pain such as fibromyalgia, and headache pain. In less common chronic pain conditions (such as pain from advanced multiple sclerosis, sickle cell disease, pain following spinal cord injury and paraplegia, or post-herpetic neuralgia), which comprise a small percentage of chronic pain patients, opioids may be considered a third-line therapy (taken if other therapies are ineffective or contraindicated) for moderate and severe pain. However, in other neurologic conditions such as polyneuropathy, no functional status markers were improved by long-term use of opioids, adverse outcomes were more common among patients with polyneuropathy receiving long-term opioids, including depression opioid dependence and opioid overdose. In addition to diagnosis, clinicians should consider risk, and some patients may not be suitable candidates on the basis of that risk. Given the narrow categories that may indicate opioids for chronic use, opioids' position as third-line therapy, and the significant risks associated with its use, long-term opioid therapy for persons with chronic pain conditions is, at most, indicated in fewer than 5% of patients with chronic pain and likely significantly fewer. For all proper indications other than terminal cancer, palliative care and

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hospice care, if prescribed, opioids should be prescribed with the lowest effective dose of immediate-release opioids taken only when needed.

65. These clinical positions are consistent with criteria employed by Professor Rosenthal in addressing scientifically acceptable use of prescription oral opioids.⁸⁷ See also the Report of Dr. Parran.

66. Professor Rosenthal produces national estimates for the theoretical maximum, scientifically acceptable use over the period 1993 to the present and finds the maximum justifiable share to be no more than 10% in every year from 2006-2016 of the actual observed MMEs of opioid prescriptions.⁸⁸ In addition to her national analysis, Professor Rosenthal conducts a similar analysis for the Bellwether communities.⁸⁹ The number of cancer deaths in the Bellwether communities are estimated from state-wide mortality rates available from US Cancer Statistics, Centers for Disease Control (CDC). State-wide incident rates are multiplied by county population to estimate Bellwether cancer mortality by year. The number of inpatient and outpatient surgeries are obtained from the American Hospital Resource File (AHRF). The number of Bellwether trauma cases are estimated based on Health Care Utilization Project (HCUP) data from the Agency on Healthcare Research and Quality (AHRQ) by multiplying the national-wide emergency room visits by Bellwether population. The theoretical maximum clinically justified usage for each of the patient groups is found by multiplying the number of cases by the appropriate average daily MME and treatment duration.

⁸⁷ Rosenthal Report, ¶ 92-94.

⁸⁸ See Rosenthal Report, Table 6, last column.

⁸⁹ The details supporting the following calculations are provided in Rosenthal Report, ¶ 100 and Table 7.

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67. The estimates of total appropriate use of opioids for the Bellwether communities for 2006-2016 are contained in Table 7 of the Rosenthal Report. The Table also shows the total actual shipments into the Bellwether communities. As shown in Rosenthal Table 7 the share of opioid shipments which were clinically justified ranges from 13.1% to 19.6% of actual shipments in Cuyahoga from 2006 through 2016 and from 6.5% to 10.0% in Summit.

68. As Professor Rosenthal explains, because every patient in these appropriate treatment groups would not have been treated with opioids, the shares of potentially appropriate shipments are overestimates of the shares of shipments that were actually directed to appropriate treatment.⁹⁰

69. The low share of shipments being appropriate is confirmed by an analysis conducted by Professor Gruber, where he found that demographic factors like age, that are correlated with disease prevalence, explain little of the cross-sectional variation in shipments.⁹¹ He observes “The extreme variation in per capita shipments across areas suggest that prescription activity, which drives shipments to an area, bears little relationship to medical need.”⁹²

70. Using the criterion that a reasonable shipment is one for an appropriate medical need and an unreasonable shipment was one for some other purpose, results in Rosenthal Table 7 indicate that the vast majority – at least 80% in Cuyahoga and at least 90% in Summit – of

⁹⁰ Rosenthal Report, ¶ 94-101.

⁹¹ Gruber Report, Section IV A.

⁹² Gruber Report, ¶ 74.

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shipments to the Bellwether communities over this period were not justified by clinical need and were therefore unreasonable.⁹³

Benefits and costs

71. When used according to scientific criteria, prescription opioids reduce pain for some users and may increase the user's ability to work. As I show here, however, the magnitude of these beneficial effects is dwarfed by the harmful effects. Thus, I also find that shipments of prescription opioids are also unreasonable from the standpoint of benefits and costs.

72. In this analysis I ignore costs of production, distribution, marketing, product development and any other cost of production of shipments. The costs I assess here are only the harmful effects on users of prescription opioids. Including consideration of conventional costs of production by manufacturers and distributors would increase the extent to which costs exceed benefits of shipments.

73. *Workforce participation and productivity.* Pain interferes with an individual's ability to work,⁹⁴ and appropriate treatment of pain enables some to work who would have otherwise been prevented from working due to pain.⁹⁵ A study of the effects of Cox-2 inhibitors (non-

⁹³ Professor Rosenthal conducts sensitivity analyses to allow for the possibility that some other patients would also be appropriately treated with opioids. She discusses this in her ¶101 and concludes that potential modifications of the clinical groups are captured in her sensitivity analyses.

⁹⁴ D.J. Gaskin and P. Richard, "The Economic Cost of Pain in the United States," *The Journal of Pain*, 13(8), 2012, pp. 715-724.

⁹⁵ Participation in the labor force benefits the individual and the wider society. The individual benefits to the degree that added income adds to their consumption opportunities. Others benefit to the degree that the added income of the worker increases public tax revenue or offsets costs others would have paid to support consumption of the individual had they been out of the labor force. For example, if someone out of the labor force is paid unemployment or disability benefits, avoiding these transfer payments benefits the public. Support for an individual out of the labor force may come from other family members, and this support is not needed if an

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opioid pain medications) finds that treatment increases workplace attendance.⁹⁶ Likewise, prescription opioids, when used appropriately for treatment of pain, may increase labor force participation and employment for pain-afflicted individuals. According to one study, the introduction of state Prescription Drug Monitoring Programs (PDMPs), intended to address prescription drug diversion and abuse, led to decreases in opioid prescriptions and increases in absence rates for short-term disabled and injured workers.⁹⁷

74. Prescription opioids, when used inappropriately, however, can lead to death, morbidity, crime, incarceration, and child maltreatment, all of which decrease labor force participation of the user and/or of others in the immediate and longer term. A paper from the Workers Compensation Research Institute studied the effect of opioid prescriptions on workers out on temporary disability with low-back pain. Long-term treatment with opioids increased the length of time workers missed work.⁹⁸

75. Some recent papers in the economics literature study the effect of opioid prescriptions on a geographic basis (rather than for populations who might benefit from appropriate treatment), and thus capture empirically both the short-term positive effects (from appropriate

individual is working and supporting themselves. In other words, how much of the benefits of labor force participation flow directly to the worker or are external to others depends on the individual circumstances.

⁹⁶ Cox-2 inhibitors are not generally used for recreational purposes. See C. Garthwaite, "The economic benefits of pharmaceutical innovations: The case of cox-2 inhibitors," *American Economic Journal: Applied Economics*, 2012, 4(3), pp. 116–137. A. Butikofer and M. M. Skira, "Missing Work is a Pain: The Effect of Cox-2 Inhibitors on Sickness Absence and Disability Pension Receipt," *Journal of Human Resources*, 2018, 53(1), pp. 71-122.

⁹⁷ A.E. Kilby, "Opioids for the masses: Welfare tradeoffs in the regulation of narcotic pain medications," 2015, Working Paper, Northeastern University. Decreases in prescriptions may have moved users to dangerous illicit drugs, explaining the increase in absentee rates.

⁹⁸ B. Savych, D. Neumark and R. Lea, (2018), "The Impact of Opioid Prescriptions on the Duration of Temporary Disability," Workers Compensation Research Institute, Cambridge, MA, March.

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pain treatment) and some negative effects (from inappropriate treatment) of opioid prescriptions on work. As one of pair of authors put it, “Because it is impossible to distinguish between legitimate and illegitimate uses of prescription opioids, we interpret these [geographic-level] results as a net effect of both types of use.”⁹⁹ These authors found that the net effect at the state level was negative.¹⁰⁰ One paper using county data on prescription rates and employment by age and gender finds that a higher rate of prescriptions has a small positive effect on employment for women, but no effect on men.¹⁰¹ Another paper found that areas with higher opioid prescription rates have lower rates of labor force participation overall.¹⁰² Finally, a very recent paper finds that increasing shipments of prescription opioids decreases the prime-age employment rate for both men and women.¹⁰³

76. Overall, on the basis of the available evidence I am of the opinion that the short-term effect of shipments on work results in a negative relationship: more shipments means less

⁹⁹ M.C. Harris, L.M. Kessler, M.N. Murray and M. E. Glenn (2019). “Prescription opioids and labor market pains,” forthcoming, *Journal of Human Resources*, pages 3-4 in web version.

¹⁰⁰ Harris *et al.* (2019) *op. cit.* study ten states using data from Prescription Drug Monitoring Programs and find that a 10% increase in prescriptions leads to a .56% decrease in labor force participation.

¹⁰¹ J. Currie, J. Jin and M. Schnell, “U.S. Employment and Opioids, Is there a Connection?” NBER Working Paper 24440, March 2018.

¹⁰² A. Krueger, “Where Have All the Workers Gone? An Inquiry into the Decline of the U.S. Labor Force Participation Rate,” Brookings Papers on Economic Activity, 2017.

¹⁰³ D. Aliprantis, K. Fee and M.E. Schweitzer (2019), “Opioids and the Labor Market,” Federal Reserve Bank of Cleveland, Working Paper no. 18-07.

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work. Furthermore, these studies, focusing on the contemporaneous and short-term effect of prescriptions underestimate the negative effects which play out over time.

77. These short-term effects are not alone. As Professor Cutler shows and as I agree, the harmful effects of prescriptions today continue for years. These longer-term harmful effects likely apply to work-related disabilities as well. And finally, other channels by which opioid shipments have negative effects on productivity over time – deaths after transition to street drugs, crime and incarceration, maltreatment that affects a child’s income as an adult -- are not captured in the contemporaneous correlation of shipments and productivity.¹⁰⁴ Deaths are a clear example of the delayed negative impact of shipments. As Professor Cutler shows, deaths today are caused by shipments years ago.¹⁰⁵ I have not undertaken a quantification of the longer-term effects on productivity from shipments (apart from death, criminality, and child maltreatment). But given the dynamics of opioid use and OUD, measurement of these longer-term effects on productivity from shipments would result in a much greater imbalance where the costs far exceed the benefits to productivity.

78. The overall purpose of my analysis here is to determine whether overall costs from shipments exceed ostensible benefits. As a result, if a particular quantification is not needed to make that determination, I can simplify the analysis by making conservative assumptions.

¹⁰⁴ Empirical research shows that the effects through these other channels swamp any possible small net positive from appropriate pain treatment (after subtracting short-term negative effects from higher rates of morbidity). For example, Florence *et al.* (2016) estimate the value of lost productivity from disease (“non-fatal costs”) to be \$16.3 billion. These are the negative effects possibly offset by positive effects of pain relief. The value of lost productivity from deaths (“fatality costs”) and incarceration were estimated at \$21.4 and \$4.2 billion, respectively. C. Florence, *et al.*, “The Economic Burden of Prescription Opioid Overdose, Abuse and Dependence in the United States, 2013,” *Medical Care*, October 2016; 54 (10), pp. 901-906. This analysis attributes disease rates to prescriptions based on specific questions in the NSDUH.

¹⁰⁵ Cutler Report, ¶ 68 where he notes shipments may have “long-term” effects.

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Therefore, when counting and valuing the effects of shipments on productivity, I will very conservatively treat the positive and negative short-term effects of shipments approximately cancel out, leaving the long-term negative effects as the net productivity effect of shipments. Specifically, any arguable short-term positive effects on productivity from pain relief are more than offset by losses due to the contemporaneous presence of disease. When tallying the net effect of shipments on productivity, I will not count lost productivity from morbidity (present in the short term), but I will count lost productivity to effects occurring over a longer term, due to death,¹⁰⁶ criminal careers, and child maltreatment.¹⁰⁷

79. Quality of life. Shipments of prescription opioids can affect a user's quality of life.

Opioids are clinically justified analgesics for some categories of patients. Reducing pain improves a patient's quality of life. On the other hand, shipments of prescription opioids put users and others at risk for OUD and its *sequelae*. These diseases reduce affected individuals' quality of life.

80. Data on the prevalence of patients who are candidates for treatment with opioids and on the prevalence of OUD (and its relation to shipments) permits a comparison of positive and negative effects of opioid shipments on quality of life. I use the same sources as Professor Rosenthal to count the number of cancer deaths, surgeries and trauma cases in the Bellwether

¹⁰⁶ As I explain below in Section IV.D., lost productivity is included within the "value of a statistical life" used to figure the economic cost of a death. Therefore, I make no separate accounting here for productivity lost associated with mortality.

¹⁰⁷ In the short-term effects, more work due to pain treatment is likely to come from clinically appropriate use whereas the short-term interference with work due to higher rates of OUD is likely to come from clinically inappropriate use. Allowing the short-term positive effects to balance out the short-term negative effects does not change the fact that by causing disease, shipments have elevated rates of OUD and interfered with work.

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communities for 2014, the most recent year for which data are available.¹⁰⁸ Professor Rosenthal also reports estimates of the appropriate duration of pain treatment for these individuals, of 64 days (on average) for people dying of cancer and 7 days on average for cases of surgery or trauma.¹⁰⁹ Combining the number of cases with the average duration of treatment yields a maximum theoretical number of days that shipments of opioids might alleviate pain. In both Cuyahoga and Summit counties, the number of days residents of the counties suffer from the presence of OUD (ignoring for this calculation *sequelae* such as HIV and Hepatitis C) vastly outweighs the maximum potential days of clinically justified pain relief. Specifically, for 2014 in Cuyahoga, days living with disease outweigh days with pain relief by a ratio of 1.8 to 1; in Summit, the ratio is 2.8 to 1.¹¹⁰

81. These ratios significantly underestimate the ratio of harms to benefits. Regarding the numerator of the ratio (harms), NSDUH, the source of estimates of the prevalence of OUD, undercounts the number of individuals suffering from OUD.¹¹¹ Regarding the denominator

¹⁰⁸ These are listed above in ¶166. See Rosenthal Report, Section X. and Table 7.

¹⁰⁹ For average duration of treatment for cancer palliative care, Dr. Rosenthal uses a number below the average number of days patients spend in hospice (see Rosenthal Report, ¶ 96 and footnote 134). For trauma and post surgery, Dr. Rosenthal uses seven days. (see Rosenthal Report, ¶¶ 98 and 99 and footnotes 137, 138 and 141).

¹¹⁰ The number of days with OUD for 2014 come from Appendix D Tables D.3a and D.3b (also see Tables 7a and 7b below) reporting estimates of OUD due to shipment based on Professor Cutler's Approach 1 (Approach 2 yields higher estimates). The number of people with OUD is 13,400 for Cuyahoga and 5,800 for Summit, corresponding to days $365 \times 13,400$ and $365 \times 5,800$ for the counties, respectively. The maximum number of days of potential pain relief is found by multiplying the number of cases for each of the three conditions times the average duration of treatment, 64 days for cancer and 7 days for the other two conditions. For Cuyahoga the number of cases are cancer deaths 2,998, trauma cases 285,338 and surgeries 84,318. For Summit the number of cases are cancer deaths 1,269, trauma cases 58,246 and surgeries 36,271. The ratio in the text for Cuyahoga is calculated by evaluating $[13,400 \times 365 / (2,998 \times 64 + 285,338 \times 7 + 84,318 \times 7)] = 1.8$. A similar operation is conducted for Summit to yield the ratio of 2.8. See Rosenthal Report for numbers of cases of cancer deaths, trauma and surgeries by county (Rosenthal Report, Attachment D, table titled Epidemiological Data Used for Appropriate Use Analysis).

¹¹¹ See Appendix D for more discussion of the NSDUH estimates.

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(benefits), the theoretical maximum of the number of patients appropriately treated is likely much higher than those who were actually appropriately treated. Not all patients who could benefit from pain treatment receive it. Of those who would benefit from treatment, opioids are often not the best choice. To illustrate the effect of taking into account of these factors on the ratios presented above, if 20% of patients who may benefit from appropriate treatment do not receive any treatment, and of those who receive treatment, 50% use opioids, the ratio of harms to benefits measured in days affected rise to 4.5 to 1 for Cuyahoga and 7.0 to 1 for Summit.¹¹² These more realistic ratios emerge correcting only the denominator for its overcount of days of benefit, and not the numerator for its undercount of the days of harm. Correcting the numerator (to account for its underestimation of the prevalence of OUD) would add harm-days and increase the ratio further.

82. As previously mentioned, the scientifically acceptable uses of prescription opioids are, at most, short-term treatment of severe acute pain, end-of-life pain/hospice care, cancer pain from active malignant disease, and a small percentage of the less common chronic pain conditions (such as pain from advanced multiple sclerosis, sickle cell disease, pain following spinal cord injury and paraplegia, or post-herpetic neuralgia) where opioids may be considered a third-line therapy (taken if other therapies are ineffective or contraindicated) for moderate and severe pain. Including these less common chronic pain patients for whom opioids are considered a third-line treatment would not materially change the magnitude of the ratios of

¹¹² The effect of assumptions that 20% are untreated and 50% of those treated are treated by opioids reduces the number of days with benefits from opioids to 40% of the previous amount $(100\%-20\%)*(50\%)$. Thus, both ratios go up by a factor of $1/.4 = 2.5$. $1.8*2.5 = 4.5$ and $2.8*2.5 = 7.0$.

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harms to benefits. These chronic-pain patients are also subject to risk of addiction. In such cases, the harms of opioid treatment may exceed the benefits.

83. The days-of-harm-to-days-of-benefit ratio could be modified by weighting days according to the relative importance of the harms from OUD and the potential benefits from pain relief. Quality-Adjusted Life Years (QALYs) are one candidate for weighting. QALYs assign a utility weight between 0 (death) and 1 (perfect health) to each year of life living in a certain state of health or illness.¹¹³ QALYs standardize utility into a single index that can be “added up” across people.¹¹⁴

84. Nothing is to be gained by a QALY-weighting exercise in this context, however, because the estimates from the literature on the QALY gain from pain treatment¹¹⁵ are in overlapping ranges as the QALYs lost from living with OUD.¹¹⁶ Weighting the top and bottom of a ratio by

¹¹³ There are several ways to derive utility valuations of each health state. One example is the Time-Trade-Off approach, in which survey respondents are asked to select the number of years in perfect health they would choose over a given number of years in their current health state. See P. Dolan, *et al.* “The Time Trade-off Method: Results from a General Population Study,” *Health Economics*, 5(2), 1996, pp. 141-154.

¹¹⁴ See M.C. Weinstein, G. Torrance, and A. McGuire, “QALYs: The Basics,” *Value in Health*, 12, 2009, pp. S5-S9.

¹¹⁵ For estimates of the QALY loss from pain, see S. Wetherington *et al.*, (2014), “Pain Quality of Life as Measured by Utilities,” *Pain Medicine* (15):865-870, Table 2. Researchers also use alternative scales for measuring utility of disease states, such as the EQ-5D used by Wetherington *et al.* Utility weights can be considered relative to a life lived in usual health, which is not 1.0. See N. Luo, *et al.*, “Self-Reported Health Status of the General Adult U.S. Population as Assessed by the EQ-5D and Health Utilities Index,” *Medical Care*, 43(11), 2005, pp. 1076-1086. This study uses the EQ-5D method to assign utility weights. Utility weights for conditions for which opioid use would be considered appropriate (i.e., conditions other than chronic pain) tend to be higher than utility weights for chronic pain, representing *less* potential for QALY gains from opioid treatment. See J. Diels *et al.*, “Mapping FACT-P to EQ-5D in a large cross-sectional study of metastatic castration-resistant prostate cancer patients,” *Qual Lif Res*, 24, 2015, pp. 591-598; M. Lidgren, *et al.*, “Health related quality of life in different states of breast cancer,” *Qual Lif Res*, 16, 2007, pp. 1073-1081.

¹¹⁶ The literature contains a range of estimates for the disease burden associated with OUD. See, for example, J.W. Bray, *et al.*, “Quality of Life as an Outcome of Opioid Use Disorder Treatment: A Systematic Review,” *Journal of Substance Abuse Treatment*, 76, 2017, pp. 88-93; M. Chetty, *et al.*, “A Systematic Review of Health Economic Models of Opioid Agonist Therapies in Maintenance Treatment of Non-Prescription Opioid Dependence,” *Addiction Science & Clinical Practice*, 12(6), 2017; H. Cranmer, *et al.*, “Health-Related Quality of Life in Opioid Use Disorder Measured by Utilities: A Systematic Literature Review,” *Value in Health*, 19(7), 2016 A387; J. De Maeyer, ,

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similar numbers does not materially change the value of the ratio. There is also considerable variation in the estimates for each condition reducing the reliability of any weighting.

85. Furthermore, analgesics could not be expected to fully restore quality of life for affected patients – in part because the analgesics are unlikely to fully eliminate pain,¹¹⁷ in part due to side effects (such as constipation) from opioid treatment,¹¹⁸ and in part because these patients are affected by other symptoms aside from pain – so the actual QALY benefits from treatment would be lower than studies of the utility loss from pain would suggest.

86. In sum, I take a similar approach to the quality-of-life impact of opioids as I did with productivity effects. As in the case of assessing productivity effects, the purpose of my analysis is to determine whether overall costs from shipments exceed ostensible benefits. I can again simplify the analysis by making conservative assumptions. In terms of quality-of-life impacts, I am of the opinion that any quality of life gains from pain relief are more than offset by increased disease burden association with OUD. In the face of ratios of costs to benefits of 4.5 to 1 or 7 to 1, to be conservative, when it comes to tallying the economic impact of opioid shipments on quality of life, I will assume the ratio is just one-to-one leading the costs to just

W. Vanderplasschen and E. Broekaert, "Quality of Life Among Opiate-Dependent Individuals: A Review of the Literature," *International Journal of Drug Policy*, 21(5), 2010, pp. 364-380; and J. P. Feelemyer, *et al.*, "Changes in Quality of Life (WHOQOL-BREF) and Addiction Severity Index (ASI) Among Participants in Opioid Substitution Treatment (OST) in Low and Middle Income Countries: An International Systematic Review," *Drug and Alcohol Dependence*, 134, 2014, pp. 251-258.

¹¹⁷ A study by Dillie *et al.* (2008) finds very low health-related quality of life of chronic pain patients who are treated with opioids relative to US population norms; see K.S. Dillie *et al.*, "Quality of Life Associated with Daily Opioid Therapy in a Primary Care Chronic Pain Sample," *J Am Board Fam Med*, 21(2), 2008, pp. 108-117. See also M.R. Kosinski, *et al.*, "An observational study of health-related quality of life and pain outcomes in chronic low back pain patients treated with fentanyl transdermal system," *Current Medical Research and Opinion*, 21(6), 2005, pp. 849-862.

¹¹⁸ F. Hjalte, *et al.*, "Treatment of Severe Pain and Opioid-induced Constipation: An Observational Study of Quality of Life, Resource Use, and Costs in Sweden," *Pain Ther*, 5, 2016, pp. 227-236.

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balance out the benefits. This is conservative because the evidence implies that the costs more than outweigh the benefits.

87. I implement this conservative assumption in my valuing of the net costs of opioid shipments in Section IV by not counting cost associated with quality-of-life reductions due to OUD and its *sequelae*. Not counting this cost certainly offsets any benefits of opioid shipments on pain relief and quality of life.

88. Summary of reasonableness/unreasonableness of shipments. From two perspectives, shipments of prescription opioids are unreasonable. First, nationally, less than 10% of shipments over the period 2006-2016 could have been devoted to clinically appropriate use.

89. Second, from the economic standpoint of costs and benefits, shipments were also unreasonable. Positive productivity and quality-of-life effects of scientifically acceptable pain treatment are vastly outweighed by the negative effects on productivity and quality of life. The net social contribution of shipments of prescription opioids is negative and large.

D. Defendants Were or Should Have Been Aware of the Interference

90. As explained in the expert reports of Dr. Perri referenced above, as well as the expert reports of Dr. David Kessler and Dr. David Egilman, the Manufacturing Defendants knew or should have known that they were making misleading statements about the safety and efficacy of the prescription opioids they manufactured. For instance, marketing by the Defendants was consistent in conveying the message that the risk of addiction in patients taking opioids for pain was minimal; that tolerance, dependence, and addiction were not serious concerns; and that opioids were the safest and most effective treatment for chronic/long-term pain. These reports

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further establish that there was no basis, however, for Defendants to make these misleading statements.

91. In addition, based on my own examination of publicly available documents and discovery produced in this litigation, Defendants had clear knowledge that the shipments had negative impacts on the public health and safety of communities across the nation, including in the Bellwether communities.

92. For example, in connection with Purdue's 2007 settlement with the United States Government mentioned above, Purdue entered into an "Agreed Statement of Facts" in which Purdue admitted that from December 12, 1995 to June 30, 2001, "certain Purdue supervisors and employees, with the intent to defraud or mislead, marketed and promoted OxyContin as less addictive, less subject to abuse and diversion, and less likely to cause tolerance and withdrawal than other pain medications ..." ¹¹⁹ Furthermore, Purdue acknowledged that it "manufactured, marketed, and sold quantities of OxyContin in interstate commerce from various locations ..." ¹²⁰

93. Additionally, in connection with Mallinckrodt's 2017 settlement with the Department of Justice mentioned above, Mallinckrodt entered into an "Administrative Memorandum of Agreement" which indicates that "[f]rom January 1, 2008, through September 30, 2011, there was an epidemic increase in diversion of the controlled substance oxycodone" and that "[t]he

¹¹⁹ Agreed Statement of Facts, *United States of America v. The Purdue Frederick Company, Inc.*, United States District Court for the Western District of Virginia, Arlington Division, (available at <http://i.bnet.com/blogs/purdue-agreed-facts.pdf>), ¶ 20.

¹²⁰ *Ibid.*, ¶ 44.

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United States alleges that Mallinckrodt, a manufacturer and distributor of oxycodone, knew about the diversion and sold excessive amounts of the most highly abused forms of oxycodone, 30 mg and 15 mg tablets, placing them into a stream of commerce that would result in diversion.”¹²¹ Furthermore, the “Acceptance of Responsibility” section of the agreement indicates that “Mallinckrodt agrees that at certain times during the Covered Time Period prior to January 1, 2012, certain aspects of Mallinckrodt’s system to monitor and detect suspicious orders did not meet the standards outlined in letters from the DEA ...”¹²²

94. As set forth above, both Cardinal and McKesson also entered into settlement agreements with the Department of Justice arising out of their failures to adhere to DEA regulations regarding the effective control over the controlled substances they distributed.¹²³ In particular, I understand both of these settlements were reached after the government alleged that these distributors’ conduct allowed the diversion of millions of prescription opioids from legitimate to non-legitimate channels, thereby placing these entities on notice that they knew or should have known their conduct was causing a substantial interference to the public health and safety of the Bellwether communities.

95. I understand from counsel that the distributors’ knowledge about the diversion, abuse, and misuse potential of the prescription opioids they distributed across the country, including

¹²¹ Administrative Memorandum of Agreement between the United States Department of Justice, Drug Enforcement Administration and Mallinckrodt, plc, p. 1, available at <https://www.justice.gov/usao-edmi/press-release/file/986026/download>.

¹²² *Ibid.*, pp. 3-4.

¹²³ <https://www.justice.gov/archive/opa/pr/2008/May/08-opa-374.html>;
https://www.justice.gov/archive/usao/co/news/2008/October08/10_2_08.html

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in Ohio and in the Bellwether communities will be further spelled out in other evidence and expert testimony.

E. Conclusion

96. Section III establishes that first, shipments of prescription opioids significantly interfered with the public health, safety and peace in the Bellwether communities. Second, shipments were unreasonable from the standpoint of being primarily directed to use without clinical justification and from the standpoint of the costs vastly outweighing the benefits. By my calculations, explained in detail in Section IV, the net economic cost of prescription opioid shipments to the two Bellwether counties over the 11-year period 2006-2016 approximately \$20 billion. Third, Defendants were aware of the addictive and other harmful effects of prescription opioids.

97. Defendants' shipments of prescription opioids meet the criteria for a public nuisance contained in ¶¶ 7-8 above. I conclude that Defendants' shipment and distribution of prescription opioids constituted a public nuisance.

IV. Quantification of the Magnitude of the Economic Costs Imposed on Bellwether Communities by Prescription Opioid Shipments

98. In this section, I address the third part of my assignment, quantifying, in dollar terms, the net economic costs imposed on the Bellwether communities by shipments of prescription opioids. To put my analysis in context, I begin with a review of some published studies quantifying some elements of the economic burden of opioids. Then, after discussion of the general economic framework for assessing the harms in dollar terms, I conduct a series of

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analyses to quantify the net economic harm in the Bellwether communities. Throughout this Section, valued harms are *due to Defendants' shipments of prescription opioids*, as described in Section III.B.

A. Review of Some Earlier Studies of Economic Burden of the Opioid Crisis

99. A variety of published studies estimate the cost of the opioid crisis in the United States. These studies review the economic cost of the opioid epidemic in terms of health care costs, criminal justice costs, lost productivity, and the cost of premature death.

100. In 2016, Curtis S. Florence and colleagues from the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention (CDC) set out “[t]o estimate the economic burden of prescription opioid overdose, abuse, and dependence from a societal perspective” across the United States for the year 2013.¹²⁴ To that end, Florence *et al.* (2016) analyzed three areas of impact: 1) health care costs, 2) criminal justice costs, and 3) lost productivity costs. For health care costs, the authors utilized de-identified medical claims data from Truven Health MarketScan® for commercial, Medicaid and Medicare health plan enrollees, while also accounting for SUD treatment costs not paid by health insurance (and therefore not in the MarketScan data), such as public programs like SAMHSA grants and private funding. Criminal justice costs included police protection, legal and adjudication, correctional facilities, and property loss due to crime. Lost productivity costs included costs from premature death due to opioid abuse, reduced productive hours due to abuse/dependence, and incarceration.

¹²⁴ Florence *et al.*, op. cit.

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101. This analysis resulted in an estimated total economic burden of prescription opioid abuse, dependence, and overdose of \$78.5 billion nationwide in 2013. More than one third of that estimated \$78.5 billion, the authors concluded, was “due to increased health care and substance abuse treatment costs,” with one quarter of the overall nationwide cost borne by public sector health care, substance abuse treatment, and criminal justice costs.¹²⁵

102. In November 2017, as a part of the Trump Administration’s investigation into the impact of the opioid crisis, the Council of Economic Advisers (“CEA”) issued a report entitled “The Underestimated Cost of the Opioid Crisis.”¹²⁶ The CEA study focused not just on prescription opioid abuse, dependence, and overdose, as previous studies – including the CDC’s – had, but also on illicit opioid abuse, including heroin. However, the study noted that of individuals presenting with an OUD in 2015, just 14% presented with heroin use disorder with no prescription opioid involvement.¹²⁷ The study also quantified “the costs of opioid-related overdose deaths based on economic valuations of fatality risk reduction,” known as “value of statistical life” (in line with what I do here and discussed in more below), which is commonly used to measure fatality risk-reduction benefits used by federal agencies.¹²⁸

103. Taking into account the 33,091 opioid-related deaths, as well as the reported 2.4 million individuals suffering with OUD in 2015, the CEA estimated economic costs of \$431.7 billion

¹²⁵ Florence, *et al.*, *op. cit.*

¹²⁶ The Council of Economic Advisers (CEA), Executive Office of the President of the United States, “The Underestimated Cost of the Opioid Crisis,” November 2017, available at: <https://www.whitehouse.gov/sites/whitehouse.gov/files/images/The%20Underestimated%20Cost%20of%20the%20Opioid%20Crisis.pdf>.

¹²⁷ *Ibid.*, p. 7.

¹²⁸ *Ibid.*, p. 3.

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resulting from fatalities (more than 85% of total costs), and \$72.3 billion for non-fatal disease.

In total, the CEA estimated the cost of the opioid crisis at more than half a trillion dollars (\$504 billion) for 2015 – more than six times greater than that estimated by Florence *et al.* (2016) for 2013 – signaling the quantitative importance of valuing a death in assessing the cost of opioids.

104. Results from the Florence *et al.* (2016) and CEA studies are listed in Table 3, along with a summary of other national studies.

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Table 3
Summary of National Studies of the Societal Costs Attributable to Opioids

Study	Year[7]	Opioids[8]	Cost Categories Included	Total Cost (billions)
Birnbaum et al. (2006) [1]	2001	Prescription	Healthcare (treatment, excess medical costs), Workplace Costs (premature death, reduced wages/employment, incarceration), Criminal Justice (police, legal, corrections)	\$8.6
Hansen et al. (2011)[2]	2006	Prescription	Healthcare (treatment, medical complications), Productivity Loss (premature death, unemployment/ subemployment, incarceration), Criminal Justice (police, legal, incarceration, costs to crime victims)	\$53.4
Birnbaum et al. (2011)[3]	2009	Prescription	Healthcare (treatment, excess medical costs, prevention, research), Workplace Costs (premature death, lost wages/employment, incarceration, excess absenteeism, excess disability, presenteeism), Criminal Justice (police, legal, corrections, lost property)	\$55.7
Florence et al. (2016)[4]	2013	Prescription	Healthcare (treatment, excess medical costs), Lost Productivity (reduced productive time/increased disability, incarceration), Criminal Justice (police, legal, corrections, lost property), Fatal costs (lost productivity, healthcare)	\$78.5
The Council of Economic Advisors (2017)[5]	2015	Prescription, Illicit	Healthcare (treatment, excess medical costs), Lost Productivity (reduced productive time/increased disability, incarceration), Criminal Justice (police, legal, corrections, lost property), Fatality costs	\$504.0
Rhyan (2017)[6]	2016	Prescription, Illicit	Healthcare (overdoses, indirect), Productivity (fatal, nonfatal), Criminal Justice, Child and Family Assistance, Education	\$95.3

Sources:

[1] Birnbaum, Howard G., et al., "Estimated Costs of Prescription Opioid Analgesic Abuse in the United States in 2001," *Clin J Pain*, Volume 22, Number 8, October 2006.

[2] Hansen, Ryan N, et al., "Economic Costs of Nonmedical Use of Prescription Opioids," *Clin J Pain*, Volume 27, Number 3, March/April 2011.

[3] Birnbaum, Howard G., et al., "Societal Costs of Prescription Opioid Abuse, Dependence, and Misuse in the United States," *Pain Medicine*, 2011, 12:657-667.

[4] Florence, Curtis S., et al., "The Economic Burden of Prescription Opioid Overdose, Abuse, and Dependence in the United States, 2013," *Medical Care*, Volume 54, Number 10, October 2016.

[5] The Council of Economic Advisers, "The Underestimated Cost of the Opioid Crisis," November 2017.

[6] Rhyan, Corwin N., "The Potential Societal Benefit of Eliminating Opioid Overdoses, Deaths, and Substance Use Disorders Exceeds \$95 Billion Per Year," *Altarum*, November 16, 2017.

[7] The year listed reflects the year in which dollar cost estimates are measured, not necessarily the year from which the data originate.

[8] The Birnbaum et al., (2006), Birnbaum et al., (2011) and Florence et al. (2016) articles estimate costs for prescription opioids, however, their estimates of excess healthcare costs cannot distinguish between individuals who abuse prescription and illicit opioids.

105. Studies of costs of the opioid crisis have been conducted at the state and local level

within Ohio. In October 2017, the Ohio-based C. William Swank Program in Rural-Urban Policy

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published “Taking Measure of Ohio’s Opioid Crisis.”¹²⁹ The Swank Report studied costs in four categories: (1) health care and treatment costs, (2) criminal justice costs, (3) lost productivity among current users, and (4) lost productivity of overdose deaths. Depending on the assumptions made about the rate of non-fatal opioid addiction and abuse, the authors estimated the costs to Ohio in 2015 to range from \$6.6 to \$8.8 billion.¹³⁰

106. A community assessment of the impact of the opioid crisis undertaken in Lorain County, just to the west of Cuyahoga County, concluded that “annual economic burden of the opioid crisis in Lorain County reached nearly \$200 million in 2016.”¹³¹ Categories of economic burden studied include lost earnings and productivity and increased costs for health care, criminal justice, children and family services, treatment and prevention.¹³²

B. Economic Framework for Valuing Harms in Dollar Terms

107. In Section III, I report some of the harms due to shipments of prescription opioids in “natural units” – *i.e.*, number of deaths, cases of disease, babies born with NAS, number of

¹²⁹ Swank Program in Rural-Urban Policy, “Taking Measure of Ohio’s Opioid Crisis,” October 2017, available at <https://cpb-us-w2.wpmucdn.com/u.osu.edu/dist/2/14548/files/2017/10/SWANK-Taking-Measure-of-Ohios-Opioid-Crisis-1vtx548.pdf>.

¹³⁰ The lower-bound estimate is derived from the survey response data from the NSDUH, which, as noted earlier, likely underestimates the true rates of disease in Ohio. The Report factors up the Ohio rate to reflect this likely undercount to get the upper-bound estimate. See Swank Report, page 1.

¹³¹ “Community Assessment of the Opioid Crisis in Lorain County, Ohio: Executive Summary,” Prepared for The Nord Family Foundation, December 20, 2017, available at https://altarum.org/sites/default/files/uploaded-publication-files/Lorain-County-Community-Assessment_Executive-Summary.pdf.

¹³² Brill and Ganz estimated state and county level per-capita costs of the opioid crisis by allocating CEA’s national estimates to states and counties using variations local costs, such as wages and health care as well as local variations in opioid-related factors such as mortality and morbidity. They estimated the total cost per-capita for Ohio to be \$3,385, which ranks fourth in the United States. A. Brill and S.Ganz, “The Geographic Variation in the Cost of the Opioid Crisis,” American Enterprise Institute, AEI Economics Working Paper 2018-03, March 2018.

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crimes, and a count of children needing foster care placement. Economic analysis often, however, requires a summing of effects in common units, and economists use dollars to do so.

108. Valuing effects or inputs in dollar terms is sometimes straightforward. For example, labor and other inputs are used to prevent crime. To find the total cost of such activities to prevent crime, one could add the public sector spending (*e.g.*, some community policing costs, some public education costs) to what individuals and groups buy privately (*e.g.*, guards, equipment). In an application of the economist's concept of "opportunity costs," these labor and other inputs are traded on markets, and market prices are available to measure the value of inputs in dollar terms.¹³³

109. In other circumstances, market prices are not available to value inputs or effects in dollars. No market price directly values death, crime victimization, suffering with illness, or the cost of a maltreated child. In these circumstances, economists have developed methods to substitute for market prices. For example, economists use tradeoffs workers make of wages for risk of death to infer the value they put on risk of death.¹³⁴ Economists use jury awards for pain and suffering to put a dollar value on the subjective cost of crime to a victim.¹³⁵

110. As needed in this section, when markets are absent, I will describe and employ conventional economic methods to value effects in dollars. The overarching goal is to "add up"

¹³³ Opportunity cost refers to value in the best alternative use. Prices set on competitive markets equal opportunity cost.

¹³⁴ See, for example, U.S. Department of Health and Human Services. 2016. "Guidelines for Regulatory Impact Analysis," available at https://aspe.hhs.gov/system/files/pdf/242926/HHS_RIAGuidance.pdf.

¹³⁵ T.R. Miller, M.A. Cohen and S.B. Rossman. "Victim costs of violent crime and resulting injuries," *Health Affairs*, 1993,12(4), pp. 186-197. M.A. Cohen, "Pain, Suffering, and Jury Awards: A Study of the Cost of Crime to Victims," *Law & Society Review*, 1988, 22(3), pp. 537-556.

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in dollar terms the economic cost of the many forms of harmful effects due to by shipments of prescription opioids into the Bellwether communities.

C. Overview of Categories of Harms and Methods of Valuation

111. Table 4 summarizes the categories of harms valued in this section. I put dollar values on the deaths, cases of OUD, babies born with NAS, crimes,¹³⁶ and child maltreatment attributable to shipments. Bellwether government costs, the final category in the table and a form of harm measured in dollars, were discussed and estimated in my Damages Report.¹³⁷

112. OUD creates harms in multiple ways, including reducing productivity and reducing quality of life, as well as increasing health care costs. As explained above, I do not count productivity losses from OUD in Table 4 because I use these costs to more than offset any productivity gains associated with opioid treatment. I also do not count any quality-of-life losses associated with OUD because I use these costs to more than offset any quality of life gains from pain reduction. Table 4 is thus a net and conservative accounting of the economic cost of the harms caused by shipments of prescription opioids.

¹³⁶ Criminal justice and police costs are accounted for in the analysis of Bellwether government costs. The source of these is the damages analyses above.

¹³⁷ See McGuire Damages Report, Section V.

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Table 4
Categories of Harms Due to Shipments and Method of Valuation

Form of Harm	Method Used for Valuation	Primary Sources for Valuation
Mortality: Deaths	Value of statistical life (VSL)	U.S. Health and Human Services guidance
Morbidity: OUD Cases	Elevated health care costs	Review of relevant literature
Babies with NAS	Elevated health care costs	Review of relevant literature
Crimes	Valuation	Review of relevant literature
Child Maltreatment	Elevated costs	Review of relevant literature
Bellwether Government Costs	Elevated costs	McGuire Report on Damages

D. Valuation in Dollar Terms: Mortality

113. An accounting of the economic cost of a death can be made with the economic concept of the value of a “statistical life,” used by researchers and government agencies to assign a dollar value to the economic cost of a death.¹³⁸ I rely on guidance from the Assistant Secretary for Planning and Evaluation (ASPE) of the U.S. Department of Health and Human Services (HHS) and choose \$9.3 million as the national value of a statistical life (VSL) in 2014. Appendix C explains some of the methodology and sources behind this estimate.¹³⁹

¹³⁸ The Value of a Statistical Life (VSL) is figured as the ratio of the maximum willingness to pay for a given reduction in the probability risk of death within a specified time period. This yields a monetary amount per statistical life saved. For example, if I were willing to pay \$10,000 to avoid a 1/100 risk of death, the VSL would be measured as $\$10,000 \times 100 = \10m . See L. Robinson and J. Hammitt “Valuing Reductions in Fatal Illness Risks: Implications of Recent Research,” *Health Economics*, 2016, 25, pp 1039-1052. The methodology for measuring the VSL is discussed in more detail in Appendix C.

¹³⁹ The VSL incorporates lost productivity from death so no separate accounting of lost productivity is necessary when VSL is applied to value the costs of mortality. “VSL is expected to be larger than expected productivity loss, because it includes the utility gains from living in addition to productivity and market consumption.” Robinson and Hammitt, *op. cit.*, p. 1041.

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114. The national value of \$9.3 million in 2014 can be adjusted to different years and different geographic areas. Since the VSL derives from consumer preferences, factors affecting willingness to pay affect the estimate of the VSL for particular local areas in particular years. Appendix C explains how differences in income and price levels are used to estimate VSL for different years for Cuyahoga and Summit counties.

115. The first rows of Tables 5a and 5b show for each county the number of deaths due to shipments in each year for each county applying the results from Professor Cutler's analysis explained above. The last two rows of the tables show, for each year and Bellwether, the VSL and the product of the VSL and the number of deaths due to shipments. This product is the economic harm from deaths. Over this 11-year time period, this measure of the economic value of lost lives is \$16.7 billion for the two counties. As in the CEA Report discussed above,¹⁴⁰ the value of lives lost comprises the largest component of the economic harm from opioid shipments.

Table 5a
Mortality and Valuation of Mortality Due to Opioid Shipments
Cuyahoga County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	104	87	111	92	138	185	191	223	234	245	504	2,114
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Opioid Deaths Due to Shipments	51	44	57	48	75	107	127	166	189	214	457	1,535
VSL (\$mil)	\$5.9	\$6.6	\$6.8	\$6.0	\$6.3	\$6.6	\$6.8	\$7.2	\$7.5	\$7.7	\$8.1	
Valuation (\$mil)	\$302	\$289	\$387	\$289	\$478	\$702	\$864	\$1,199	\$1,413	\$1,655	\$3,702	\$11,279

See Appendix C for sources and calculation notes.

¹⁴⁰ CEA, op. cit.

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Table 5b
Mortality and Valuation of Mortality Due to Opioid Shipments
Summit County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	25	31	21	23	45	34	60	56	105	135	269	804
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Opioid Deaths Due to Shipments	12	16	11	12	25	20	40	42	85	118	244	623
VSL (\$mil)	\$6.5	\$7.1	\$7.8	\$7.3	\$7.2	\$7.6	\$8.2	\$8.4	\$8.7	\$8.9	\$9.1	
Valuation (\$mil)	\$80	\$111	\$83	\$88	\$176	\$148	\$326	\$348	\$740	\$1,048	\$2,229	\$5,377

See Appendix C for sources and calculation notes.

E. Valuation in Dollar Terms: Morbidity

116. I conservatively value the net economic effects of shipment-caused morbidity in terms of higher health care costs only. The opioid epidemic has increased health care utilization. Individuals with OUD consume more health care both to treat their OUD (*e.g.*, addiction services, MAT, etc.) and to treat comorbidities, such as hepatitis C and HIV, which occur in greater frequencies among patients with OUD.¹⁴¹ In this section, I estimate the additional health care costs attributable to opioid shipments.

117. Researchers examining the additional health care costs resulting from OUD have measured the magnitude of excess health care costs due to OUD using a “cost-of-illness” methodology. The basic approach is to compare the health care costs of individuals with OUD to a comparison group of individuals with similar insurance, sociodemographic and other characteristics. The goal of the comparison is to estimate the costs for all health care, not just

¹⁴¹ J. S. Morrison and L. Dattilo, “America’s Dangerous Syndemic: Opioid Addiction, HIV, and Hepatitis C,” *Center for Strategic & International Studies*, December 2017; P.J. Peters, *et al.*, “HIV Infection Linked to Injection Use of Oxycodone in Indiana, 2014-2015,” *The New England Journal of Medicine*, July 21, 2016, pp. 229-239; Nilsen, E., “America’s opioid crisis has become an ‘epidemic of epidemics,’” *Vox*, March 6, 2018, available at <https://www.vox.com/2018/3/6/16453530america-opioid-crisis-epidemic-bacterial-endocarditis-hepatitis-c>.

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OID treatment, resulting from OID after controlling for other health factors. So, for example, suppose there are two 40-year-old men with private insurance. One man suffers from OID and the second man does not. These analyses compare the health care spending over 12 months for these two men, starting at the time of the first OID diagnosis for the individual with OID. The difference in their health care spending is the excess health care cost attributable to OID.

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Table 6
Literature Documenting the Elevated Health Care Costs of OUD

Study	Year[7]	Patient Population Studied	Additional Annual Cost for OUD Individuals
Birnbaum et al., (2006)[1]	2001	Commercial	\$9,449
		Publicly Insured	\$12,394
		Uninsured	\$4,566
McAdam-Marx et al., (2010)[2]	2002-2003	Medicaid	\$5,874
White et al., (2005)[3]	2003	Commercial	\$14,054
Rice et al., (2014)[4]	2012	Commercial	\$11,376
Florence et al., (2016)[5]	2013	Commercial	\$15,500
		Medicare	\$17,052
		Medicaid	\$13,743
Kirson et al., (2017)[6]	2015	Commercial	\$14,810

[1] Birnbaum, Howard G., Alan G. White, Jennifer L. Reynolds, Paul E. Greenberg, Mingliang Zhang, Sue Vallow, Jeff R. Schein, Nathaniel P. Katz, "Estimated Costs of Prescription Opioid Analgesic Abuse in the United States in 2001," *Clin J Pain*, Volume 22, Number 8, October 2006.

[2] McAdam-Marx, Carrie, Carl L. Roland, Jody Cleveland, Gary M. Oderda, "Costs of Opioid Abuse and Misuse Determined From a Medicaid Database," *Journal of Pain & Palliative Care Pharmacotherapy*, 24:1, 5-18.

[3] White, Alan G., Howard G. Birnbaum, Milena N. Mareva, Maham Daher, Susan Vallow, Jeff Schein, Nathaniel Katz, "Direct Costs of Opioid Abuse in an Insured Population in the United States," *J Manag Care Pharm*, 2005;11(6):469-79.

[4] Rice, J. Bradford, Noam Y. Kirson, Amie Shei, Caroline J. Enloe, Alice Kate G. Cummings, Howard G. Birnbaum, Pamela Holly, and Rami Ben-Joseph. "The Economic Burden of Diagnosed Opioid Abuse Among Commercially Insured Individuals," *Postgraduate Medicine*, Volume 126, Issue 4, July/August 2014.

[5] Florence, Curtis S., Chao Zhou, Feijun Luo, and Likang Xu, "The Economic Burden of Prescription Opioid Overdose, Abuse and Dependence in the United States, 2013." *Medical Care*, Vol 54, No. 10, 2016.

[6] Kirson, Noam Y., Lauren M. Scarpati, Caroline J. Enloe, Aliya P. Dincer, Howard G. Birnbaum, and Tracy J. Mayne. "The Economic Burden of Opioid Abuse: Updated Findings." *J Manag Care Spec Pharm*. 2017;23(4):427-45.

[7] The year listed reflects the year in which dollar cost estimates are measured, not necessarily the year from which the data originate.

118. Despite some differences in population covered, form of health insurance, definition of OUD, and the chosen comparison group, there is a rough consensus from the research literature that the additional health care costs for an individual with OUD in the 2006 through

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2016 period range from approximately \$11,000 to \$17,000 per patient per year.¹⁴² (See Table 6). Florence *et al.* (2016) use the same “cost of illness” methodology to estimate the excess health care costs attributable to OUD for patients with Medicare, Medicaid and private insurance in 2013.¹⁴³ They find that health care costs were \$15,500 higher for commercially insured patients, \$17,052 higher for Medicare patients, and \$13,743 higher for Medicaid patients.

119. I use the Florence *et al.* (2016) findings, along with the number of person-years with OUD estimated in Tables 7a and 7b to estimate excess health care costs attributable to OUD in the Bellwether counties. As explained in detail in Appendix H, I estimate the number of OUD individuals covered by Medicare, Medicaid and private insurance plans from national surveys. I multiply the number of OUD person-years in each insurance category by the excess health care costs attributable to OUD in each year, adjusted for health care inflation. Excess health care costs were \$1.4 billion for individuals with OUD in Cuyahoga County and \$587 million for individuals with OUD in Summit County. See Tables 7a and 7b.

¹⁴² Conceptually, these studies all use this matching methodology to compare health care costs, however, there are small differences between the studies. For example, studies may use different slightly different measurement periods or may use different numbers of control patients.

¹⁴³ Florence *et al.* (2016) use Truven Health MarketScan Research Databases for commercial, Medicaid and Medicare enrollees. They identify OUD individuals using ICD-9-CM codes for opioid abuse, dependence or overdose, which include costs due to prescription opioid or heroin dependence. All individuals included in the study had 18 months of continuous insurance coverage in the data. The first six months of data were used for matching OUD to non-OUD individuals and the final 12 months were used for cost comparison. Florence *et al.* (2016), p. 902.

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Table 7a
Morbidity and Valuation of Morbidity Due to Shipments
Cuyahoga County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD	1.18%	1.15%	1.19%	1.36%	1.38%	1.42%	1.55%	1.48%	1.53%	1.44%	1.40%	
County Population 12 + (000s)	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	12,040.8
Persons with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	164.8
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Persons with OUD Due to Opioid Shipments (000s)	6.5	6.4	6.7	7.8	8.2	8.9	11.2	12.0	13.4	13.6	13.7	108.5
Elevated Health Costs (\$mil)	\$65	\$67	\$72	\$87	\$95	\$107	\$142	\$158	\$185	\$194	\$205	\$1,376

See Appendix D for sources and calculation notes.

Table 7b
Morbidity and Valuation of Morbidity Due to Shipments
Summit County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD	1.18%	1.15%	1.19%	1.36%	1.38%	1.42%	1.55%	1.48%	1.53%	1.44%	1.40%	
County Population 12 + (000s)	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Persons with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	70.0
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Persons with OUD Due to Opioid Shipments (000s)	2.7	2.7	2.8	3.3	3.5	3.8	4.8	5.1	5.8	5.9	5.9	46.2
Elevated Health Costs (\$mil)	\$27	\$28	\$30	\$37	\$40	\$46	\$60	\$68	\$79	\$84	\$88	\$587

See Appendix D for sources and calculation notes.

F. Valuation in Dollar Terms: Children Born with NAS

120. Due to data limitations, valuing the harms due to NAS in this section is confined to excess hospital costs associated with birth. While the dollar amount of harms due to neonatal abstinence syndrome described in this Report is small relative to other costs attributable to opioid shipments, these adverse effects are likely to be vastly underestimated relative to the full costs over the course of a child's lifetime. Firstly, in addition to health care costs, cases of NAS may also require monitoring and follow-up by child welfare services, which results in

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increased labor costs.¹⁴⁴ Additionally, there may be longer-term adverse outcomes associated with NAS. While the effects of NAS on long-term outcomes are more difficult to study due to confounding factors associated with opioid use and abuse, there is compelling evidence that NAS is associated with several adverse outcomes in infancy and childhood, including neurodevelopmental and neurobehavioral impairment,¹⁴⁵ maltreatment,¹⁴⁶ mental and behavioral disorders,¹⁴⁷ and visual impairment.¹⁴⁸ Children with NAS have also been found to have impaired school performance,¹⁴⁹ and to be at increased risk for educational disability and needing special education services,¹⁵⁰ relative to comparison children. All of these harms

¹⁴⁴ U.L. França, S. Mustafa and M.L. McManus, "The Growing Burden of Neonatal Opiate Exposure on Children and Family Services in Massachusetts," *Child Maltreatment*, 2011 21(1), pp. 80-84.

¹⁴⁵ R.W. Hunt, *et al.*, "Adverse neurodevelopmental outcome of infants exposed to opiate in-utero," *Early Human Development*, 2008, 84(1), pp. 29-35; L. McGlone and H. Mactier, "Infants of opioid-dependent mothers: neurodevelopment at six months," *Early Human Development*, 2015, 91(1), pp. 19-21; E. Nygaard, *et al.*, "Longitudinal cognitive development of children born to mothers with opioid and polysubstance use," *Pediatric Research*, 2015, 78(3), pp. 330-335; A. Baldacchino *et al.*, "Erratum: neurobehavioral consequences of chronic intrauterine opioid exposure in infants and preschool children: a systematic review and meta-analysis," *BMC Psychiatry*, 2015, 15(1), p. 134; T.S. Rosen and H.L. Johnson, "Children of methadone-maintained mothers: follow-up to 18 months of age," *The Journal of Pediatrics*, 101(2), 1982, pp. 192-196; R. Bunikowski, *et al.*, "Neurodevelopmental outcome after prenatal exposure to opiates," *European Journal of Pediatrics*, 1998, 157(9), pp. 724-730.

¹⁴⁶ Uebel *et al.*, *op. cit.*

¹⁴⁷ Uebel *et al.*, *op. cit.*

¹⁴⁸ L. McGlone *et al.*, "Visual outcome in infants born to drug-misusing mothers prescribed methadone in pregnancy," *British Journal of Ophthalmology*, 2014, 98(2), pp. 238-245; R. Hamilton, *et al.*, "Ophthalmic, clinical and visual electrophysiological findings in children born to mothers prescribed substitute methadone in pregnancy," *British Journal of Ophthalmology*, 2010, 94(6), pp. 696-700; K.S. Cornish, *et al.*, "The short-and long-term effects on the visual system of children following exposure to maternal substance misuse in pregnancy," *American Journal of Ophthalmology*, 2013, 156(1), pp. 190-194; Uebel *et al.*, *op. cit.*

¹⁴⁹ J.L. Oei, *et al.*, "Neonatal abstinence syndrome and high school performance," *Pediatrics*, 2017, 139(2), e20162651, pp. 1-10.

¹⁵⁰ M.A. Fill, *et al.*, "Educational disabilities among children born with neonatal abstinence syndrome," *Pediatrics*, 2018, 142(3), e20180562.

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represent additional social costs of opioid use that have not, due to data limitations, been quantified in this Report.

121. A NAS birth is associated with more intensive hospital utilization than other births, including, for example, increased length of stay and increased risk of admission to the neonatal intensive care unit, resulting in excess costs.¹⁵¹

122. To quantify the excess hospital charges due to NAS, I use the difference between the average hospital charge for an NAS case in Ohio and the average hospital charge for all births in Ohio in each year, as reported in Ohio Department of Health statewide data.¹⁵² These excess hospital charges are reported in Tables 8a and 8b below. I then use these excess hospital charges to estimate excess hospital costs by multiplying charges by net revenue-to-charge ratios from the American Hospital Association. Tables 8a and 8b report the total estimated hospital costs of NAS attributable to opioid shipments; these costs were \$9.4 million in Cuyahoga County and \$6.7 million in Summit county between 2006-2016.

Table 8a
Neonatal Abstinence Syndrome (NAS) and Valuation
Cuyahoga County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid-Related NAS Cases	19	23	30	45	60	74	94	117	117	117	141	837
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
NAS Cases Due to Shipments	9	12	15	24	33	43	62	87	95	102	128	609
Excess Hospital Costs Due to NAS	\$12,885	\$19,525	\$18,795	\$22,276	\$18,587	\$15,731	\$14,671	\$15,153	\$16,823	\$14,011	\$13,397	
Valuation of NAS Health Costs Due to Shipments (\$ mil)	\$0.12	\$0.23	\$0.29	\$0.53	\$0.61	\$0.67	\$0.91	\$1.32	\$1.59	\$1.43	\$1.71	\$9.41

See Appendix E for sources and calculation notes.

¹⁵¹ Wong *et al.*, *op. cit.* See also: T.E. Corr and C.S. Hollenbeak, "The Economic Burden of Neonatal Abstinence Syndrome in the United States," *Addiction*, 2017, 112, pp. 1590-1599.

¹⁵² See Appendix E.

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Table 8b
Neonatal Abstinence Syndrome (NAS) and Valuation
Summit County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid-Related NAS Cases	13	16	20	31	41	50	63	89	89	89	89	589
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
NAS Cases Due to Shipments	6	8	10	16	22	29	42	66	72	77	81	430
Excess Hospital Costs Due to NAS	\$12,885	\$19,525	\$18,795	\$22,276	\$18,587	\$15,731	\$14,671	\$15,153	\$16,823	\$14,011	\$13,397	
Valuation of NAS Health Costs Due to Shipments (\$ mil)	\$0.08	\$0.16	\$0.20	\$0.36	\$0.41	\$0.45	\$0.62	\$1.00	\$1.21	\$1.08	\$1.08	\$6.65

See Appendix E for sources and calculation notes.

G. Valuation in Dollar Terms: Crime

123. Appendix F describes the methods I use for counting the number of crimes in the Bellwether communities due to shipments of prescription opioids, and for valuing the cost of crimes in dollars. In terms of counting crimes, I begin with a standard database reporting number of crimes by category of crime; specifically, I calculate the total criminal activity reported for all reporting Law Enforcement Agencies in the National Incident-Based Reporting System (NIBRS) data in which the ‘primary county’ listed is Cuyahoga/Summit. I then apply methods from Professor Cutler’s report to attribute a share of those crimes to shipments of opioids.

124. A useful framework used in the economic literature on crime classifies costs into direct, indirect, and intangible costs.¹⁵³ Direct costs include the costs of private crime deterrents (alarms, security), public expenditures on police, and the value of property lost due to criminal activity. Indirect costs of crime include the productivity loss for victims of violent crime and the

¹⁵³ Two literature reviews are N. Wickramasekera, *et al.*, “Cost of crime: A systematic review,” *Journal of Criminal Justice*, 2015, 43(3), pp. 218-228 and K.E. McCollister, M.T. French and H. Fang, “The cost of crime to society: New crime-specific estimates for policy and program evaluation,” 2010, 108(1-2), pp. 98-109.

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loss in productivity due to addiction and incarceration for the perpetrator. Finally, intangible costs consist of pain, suffering, and psychological consequences borne by crime victims and the public. Details on the dollar valuation are also contained in Appendix F.

125. Direct costs of crime, such as property loss, medical care expenses, and public or private expenditures on crime deterrents, are often estimated by combining several sources of data, including government data on criminal justice system costs, surveys on medical expenses, and property loss associated with crime.¹⁵⁴ The main component of the indirect costs of crime is productivity loss of both the victims and the perpetrators. Crimes that result in injury or hospitalization lead to a reduction in victim productivity. The opportunity cost to criminals of engaging in productive activities by criminals is also included in the indirect cost of crime.¹⁵⁵ Finally, intangible costs include the pain, emotional and psychological consequences of criminal activity imposed on victims and the public. The “jury-compensation approach” uses monetary amounts awarded by juries in injury cases, net of medical costs and lost wages, to estimate intangible costs to victims.¹⁵⁶ A second method for estimating intangible costs, the contingent valuation approach, uses surveys to estimate respondents’ willingness-to-pay for reductions in hypothetical risk of pain, suffering or various types of crimes.

¹⁵⁴ See D.A. Anderson, “The cost of crime,” *Foundations and Trends® in Microeconomics* 7.3 (2012): 209-265, chapter 4, for a discussion and a representative example of the data-aggregation methods used in crime costing studies.

¹⁵⁵ These costs are often calculated by multiplying the minimum wage or other unskilled labor wage by the amount of time spent by criminals in incarceration. Note this assumes incarcerated individuals would work full time if not incarcerated. While this is a crude measure, is its likely an underestimation of this form of crime cost, because there it does not include the opportunity cost of crime that does not result in incarceration. See S. Aos, *et al.* “The Comparative Costs and Benefits of Programs to Reduce Crime. Version 4.0,” (2001) for a discussion of this point.

¹⁵⁶ This methodology was developed in M.A. Cohen(1988), *op cit.*

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126. To avoid any double counting of costs of crime already accounted for in the budget impacts on the Bellwether governments, I deduct from costs the direct costs to the criminal justice system. This is conservative because crime in a county imposes direct costs not just on the county government but also on other governments with criminal jurisdiction within the county, such as, in this case, the city governments of Akron and Cleveland. Criminal justice costs of crime for the Bellwether county governments are included in the costs reported in Table 11 below.

127. Tables 9a and 9b present dollar estimates of the costs of crime, across all types of offenses, per Bellwether county and year due to shipments. These figures include direct, indirect and intangible costs as described above. In total, I estimate that shipments from 2006-2016 led to \$327 million in Cuyahoga county, and \$126 million in Summit county.

Table 9a
Crime and Valuation of Crime Due to Shipments
Cuyahoga County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Crimes	2,636	2,531	3,082	3,155	3,498	3,728	4,648	4,641	4,932	5,441	5,665	43,957
Valuation of Crimes (\$mil)	\$19	\$19	\$22	\$23	\$25	\$25	\$32	\$33	\$35	\$43	\$50	\$327

See Appendix F for sources and calculation notes.

Table 9b
Crime and Valuation of Crime Due to Shipments
Summit County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Crimes	934	903	1,275	1,350	1,556	1,616	1,918	2,324	2,600	3,021	3,281	20,779
Valuation of Crimes (\$mil)	\$6	\$6	\$8	\$8	\$9	\$10	\$12	\$13	\$16	\$18	\$20	\$126

See Appendix F for sources and calculation notes.

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H. Valuation in Dollar Terms: Child Maltreatment

128. Appendix G describes the methods I use for counting the number of victims of child maltreatment in the Bellwether communities due to shipments of prescription opioids, and for valuing the excess costs incurred. In terms of counting victims, I rely on Dr. Young's reporting of the number of victims of substantiated maltreatment in the two counties. I then apply methods from Professor Cutler's report to attribute a share of these victims to shipments of opioids.

129. The research literature establishes that child maltreatment (abuse or neglect) devastates a child, lowering educational attainment;¹⁵⁷ reducing cognitive development;¹⁵⁸ increasing the need for special education services;¹⁵⁹ lowering employment and earnings;¹⁶⁰

¹⁵⁷ R. Gilbert, *et al.*, "Burden and consequences of child maltreatment in high-income countries," *The Lancet*, 373, 2009, 68-81; J. Currie and C.S. Widom, "Long-term consequences of child abuse and neglect on adult economic well-being," *Child Maltreatment*, 15(2), 2010, pp. 111-120; J.P. Mersky and J. Topitzes, "Comparing early adult outcomes of maltreated and non-maltreated children: A prospective longitudinal investigation," *Children and Youth Services Review*, 32(8), 2010, pp. 1086-1096; Doyle & Aizer, 2018, *op. cit.*; A. Bald, E. Chyn, J.S. Hastings, and M. Machelett, "The Causal Impact of Removing Children from Abusive and Neglectful Homes," NBER Working Paper 25419, January 2019.

¹⁵⁸ K.L. Hildyard and D.A. Wolfe, "Child neglect: developmental issues and outcomes," *Child Abuse & Neglect*, 26, 2002, pp. 679-695; C.M. Perez and C.S. Widom, "Childhood victimization and long-term intellectual and academic outcomes," *Child Abuse & Neglect*, 18(8), 1994, pp. 617-633; J. Currie & C.S. Widom, 2010, *op. cit.*

¹⁵⁹ M. Jonson-Reid, *et al.*, "A prospective analysis of the relationship between reported child maltreatment and special education eligibility among poor children," *Child Maltreatment*, 9(4), 2004, pp. 382-394; R.J. Gelles and S. Perlman, "Estimated Annual Cost of Child Abuse and Neglect," Prevent Child Abuse America; April 2012, available at https://preventchildabuse.org/wp-content/uploads/2016/02/PCA_COM2012-1.pdf; R. Gilbert *et al.*, 2009, *op. cit.*

¹⁶⁰ R.J. Gelles & S. Perlman, 2012, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; J. Currie & C.S. Widom, 2010, *op. cit.*; J.P. Mersky and J. Topitzes, 2010, *op. cit.*

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and causing higher rates of preventable deaths,¹⁶¹ obesity,¹⁶² depression,¹⁶³ substance abuse,¹⁶⁴ and PTSD.¹⁶⁵ Furthermore maltreatment elevates rates of juvenile delinquency¹⁶⁶ and crime.¹⁶⁷

These negative effects of maltreatment are costly.

130. I focus on the research studies of lost earnings and special education costs, as these are the outcomes for which there is strong evidence of adverse effects due to childhood maltreatment. Again, to avoid double counting with the costs reported in Table 11 below, I do not include excess crime-related costs for the victims of maltreatment.

131. For each outcome of interest, I first determine the estimated incremental effect of maltreatment on the outcome. For example, maltreated children are 8.6 percentage points

¹⁶¹ A. Hjern, B. Vinnerljung, and F. Lindblad, "Avoidable mortality among child welfare recipients and intercountry adoptees: a national cohort study," *Journal of Epidemiology & Community Health*, 58(5), 2004, pp. 412-417; Doyle & Aizer, 2018, *op. cit.*

¹⁶² L.M. Berger and J. Waldfogel, "Economic Determinants and Consequences of Child Maltreatment," OECD Social, Employment and Migration Working Paper No. 111, April 2011, OECD Publishing, Paris, available at <http://dx.doi.org/10.1787/5kgf09zj7h9t-en>; R. Gilbert *et al.*, 2009, *op. cit.*

¹⁶³ L.M. Berger and J. Waldfogel, 2011, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; A. Bald, E. Chyn, J.S. Hastings, and M. Machelett, 2019, *op. cit.*; F. Wulczyn, 2009, *op. cit.*; J.P. Mersky and J. Topitzes, 2010, *op. cit.*; C.S. Widom, K. DuMont, and S.J. Czaja, "A prospective investigation of major depressive disorder and comorbidity in abused and neglected children grown up," *Archives of General Psychiatry*, 64(1), 2007, pp. 49-56.

¹⁶⁴ L.M. Berger and J. Waldfogel, 2011, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; F. Wulczyn, 2009, *op. cit.*; J.P. Mersky and J. Topitzes, 2010, *op. cit.*; C.S. Widom, K. DuMont, and S.J. Czaja, 2007, *op. cit.*

¹⁶⁵ L.M. Berger and J. Waldfogel, 2011, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; C.S. Widom, K. DuMont, and S.J. Czaja, 2007, *op. cit.*; C.S. Widom, "Posttraumatic stress disorder in abused and neglected children grown up," *American Journal of Psychiatry*, 156(8), 1999, pp. 1223-1229.

¹⁶⁶ C.S. Widom, "The Cycle of Violence," *Science*, 244(4901), 1989, pp. 160-166; R.J. Gelles & S. Perlman, 2012, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; M.G. Maxfield and C.S. Widom, "The cycle of violence: Revisited 6 years later," *Archives of Pediatrics & Adolescent Medicine*, 150(4), 1996, pp. 390-395; C.S. Widom and M.G. Maxfield, "An Update on the 'Cycle of Violence.' Research in Brief," Department of Justice, Washington, DC, National Institute of Justice; February 2001, available at <https://files.eric.ed.gov/fulltext/ED451313.pdf>.

¹⁶⁷ J. Currie and E. Tekin, "Does child abuse cause crime?" NBER Working Paper 12171, April 2006; Doyle & Aizer, 2018, *op. cit.*; R.J. Gelles & S. Perlman, 2012, *op. cit.*; R. Gilbert *et al.*, 2009, *op. cit.*; Widom, 1989, *op. cit.*; J. Currie and E. Tekin, "Understanding the cycle childhood maltreatment and future crime," *Journal of Human Resources*, 47(2), 2012, pp. 509-549; J.P. Mersky and J. Topitzes, 2010, *op. cit.*; M.G. Maxfield and C.S. Widom, 1996, *op. cit.*; C.S. Widom and M.G. Maxfield, 2001, *op. cit.*

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more likely to need special education services compared with control children (22.3% vs. 13.7%).¹⁶⁸ Following methodology by Fang *et al.* (2012),¹⁶⁹ I multiply the total estimated cost of special education services by 0.086 to arrive at an estimate of the excess special education costs for each case of childhood maltreatment. See Appendix G for additional details on these and other components of the estimates and the literature on the social costs of childhood maltreatment.

132. Tables 10a and 10b report the dollar estimates of the cost of child maltreatment for the two Bellwether communities, using the counts of maltreatment from Section III. I estimate that the social costs of cases of maltreatment attributable to opioid shipments between 2006-2016 is \$401 million for Cuyahoga and \$297 million for Summit counties.¹⁷⁰ Lost earnings (*i.e.*, productivity losses) are the largest component of costs.

Table 10a
Child Maltreatment Cases and Valuation Due to Shipments
Cuyahoga County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Cases of Maltreatment	2,043	1,924	2,073	1,452	1,738	2,092	2,156	2,502	2,281	2,316	2,513	23,090
Share Harms Due to Opioid Shipments	2.2%	2.7%	3.2%	3.7%	4.0%	4.2%	4.8%	6.6%	8.2%	9.6%	13.5%	
Maltreatment Cases Due to Opioid Shipments	45	52	65	53	70	88	104	164	186	222	340	1,391
Social Cost of Maltreatment by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment (\$mil)	\$13.1	\$14.9	\$18.9	\$15.4	\$20.1	\$25.4	\$29.9	\$47.3	\$53.7	\$64.0	\$97.9	\$400.6

See Appendix G for sources and calculation notes.

¹⁶⁸ M. Jonson-Reid, *et al.*, 2004, *op. cit.*

¹⁶⁹ X. Fang, *et al.*, "The economic burden of child maltreatment in the United States and implications for prevention," *Child Abuse & Neglect*, 2012, 36, pp. 156-165.

¹⁷⁰ See Appendix G for further details on these calculations.

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Table 10b
Child Maltreatment and Valuation Due to Shipments
Summit County, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Cases of Maltreatment	1,319	1,117	901	944	715	643	674	601	579	757	886	9,136
Share Harms Due to Opioid Shipments	2.1%	2.6%	3.3%	4.6%	12.0%	12.2%	15.5%	18.3%	19.5%	21.8%	27.5%	
Maltreatment Cases Due to Opioid Shipments	28	29	30	44	86	79	105	110	113	165	244	1,031
Social Cost of Maltreatment by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment (\$mil)	\$8.1	\$8.2	\$8.6	\$12.6	\$24.7	\$22.6	\$30.1	\$31.7	\$32.5	\$47.6	\$70.1	\$296.9
See Appendix G for sources and calculation notes.												

I. Bellwether Government Costs Due to Shipments

133. My Damages Report estimates the costs incurred by the Bellwether governments as a result of opioid shipments due to misconduct. As detailed in that report, I identified government divisions impacted by the opioid crisis and the costs within those divisions that were potentially affected by the opioid crisis.¹⁷¹ To those estimates of potentially affected costs, I applied shares of harm due to Defendants' misconduct estimated by Professor Cutler and report my estimates of costs incurred by the Bellwether governments as a result of Defendants' misconduct.¹⁷²

134. As discussed above, in this Report, I focus on all opioid shipments when assessing costs (not just the share of shipments Professor Rosenthal attributed to misconduct). Appendix E to my Damages Report included these estimates,¹⁷³ and they are reproduced here as Table 11.

¹⁷¹ See, McGuire Damages Report, Sections III and IV.

¹⁷² See McGuire Damages Report, Section V.

¹⁷³ See McGuire Damages Report, Appendix IV.E. Tables E.3 and E4.

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Bellwether county costs attributable to shipments totaled \$172.4 million for Cuyahoga and \$98.7 million for Summit over the period 2006-2016.

Table 11
Government Costs Attributable to Opioid Shipments
2006-2016 (millions)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Cuyahoga County (\$mil)	\$6.4	\$7.4	\$9.5	\$10.4	\$11.7	\$12.7	\$14.7	\$18.9	\$22.1	\$25.7	\$32.9	\$172.4
Summit County (\$mil)	\$2.0	\$2.2	\$2.9	\$4.1	\$8.0	\$7.9	\$9.5	\$12.4	\$14.0	\$15.9	\$19.8	\$98.7
Total (\$mil)	\$8.4	\$9.6	\$12.4	\$14.5	\$19.8	\$20.5	\$24.3	\$31.3	\$36.1	\$41.6	\$52.7	\$271.1

Sources: McGuire Cost Report, Tables E.3 and E.4.

J. Sum of Economic Costs Imposed on Bellwether Communities Due to Shipments

135. Table 12 summarizes the costs to the Bellwether communities from the five categories of harm assess here, excess mortality, morbidity, babies born with NAS, crime, and cases of child maltreatment. In addition, Table 12 includes the costs to the county governments in Cuyahoga and Summit tallied in my Damages Report. In total, over the 11-year period, shipments of prescription opioids imposed net economic costs on the Bellwether communities of approximately \$13.6 billion in Cuyahoga and approximately \$6.5 billion for Summit. Harms include those associated with heroin, fentanyl and other drugs to the degree that harms from these drugs can be attributed to shipments of prescription opioids.

136. These results are conservative for two reasons (in addition to the reasons discussed above that apply to component estimates.) First, the accounting stops in 2016 because of data limitations. Some categories of costs could be estimated for later years, but to keep the results consistent across cost categories, I only included costs through 2016 in the tables. The harms due to opioid shipments are ongoing and are much higher in the later years, after the crisis

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accelerated, compared to the earlier years. Costs to Cuyahoga in 2016 alone were almost \$4.1 billion and to Summit were approximately \$2.4 billion. Costs for 2016 represent reasonable estimates of costs for 2017 and 2018 and could be added to the total if required.

137. The second reason is that not all categories of costs are included in the five categories assessed here. Costs not counted here include costs to other governments in the counties, such as the City of Cleveland, the City of Akron, school districts and other public agencies. Also not counted, among other categories, are losses in property values and property taxes due to opioid-related crime, and losses in sales taxes.

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Table 12
Summary of Harms Due to Shipments Valued in Dollars, 2006-2016
(millions)

Form of Harm	Method of Valuation	Cuyahoga	Summit	Total
Mortality: Deaths	Value of statistical life (VSL)	\$11,279	\$5,377	\$16,656
Morbidity: OUD Cases	Elevated health care costs	\$1,376	\$587	\$1,963
Babies with NAS	Elevated health care costs	\$9	\$7	\$16
Crimes	Valuation	\$327	\$126	\$453
Child Maltreatment	Elevated costs	\$401	\$297	\$698
Bellwether Government Costs	Elevated costs	\$172	\$99	\$271
Totals		\$13,564	\$6,492	\$20,056

Sources: Tables 5a, 5b, 7a, 7b, 8a, 8b, 9a, 9b, 10a, 10b and 11 of this Report.

138. As noted above in ¶ 45, I only report results using Dr. Cutler's Approach 1 in this Report.

Appendix I includes all the tables resulting from my analysis using Dr. Cutler's Approach 2.

Table 13 below summarizes the results from reliance on Approach 2.

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Table 13
Summary of Monetary Value of Harms Due to Prescription Opioid Shipments
Based on Dr. Cutler's Approach 2
2006-2016 (millions)

Form of Harm	Method of Valuation	Cuyahoga	Summit	Total
Mortality: Deaths	Value of statistical life (VSL)	\$13,306	\$6,059	\$19,366
Morbidity: OUD Cases	Elevated health care costs	\$1,738	\$739	\$2,477
Babies with NAS	Elevated health care costs	\$11	\$8	\$19
Crimes	Valuation	\$420	\$159	\$579
Child Maltreatment	Elevated costs	\$485	\$360	\$845
Bellwether Government Costs	Elevated costs	\$215	\$119	\$334
Totals		\$16,176	\$7,445	\$23,621

Sources: Tables I.5a, I.5b, I.7a, I.7b, I.8a, I.8b, I.9a, I.9b, I.10a, I.10b and I.11 of Appendix I.

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March 25, 2019



Prof. Thomas McGuire

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Appendix A
Professor McGuire CV and Listing of Testimony

February 26, 2019

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Education:

Year	Degree	Institution	Field
1971	B.A. Summa Cum Laude	Princeton University	Economics
1976	Ph.D.	Yale University	Economics

Academic Appointments:

Year	Academic Title	Institution
2001-present	Professor	Harvard Medical School
1987-2001	Professor	Boston University
1981-1996	Visiting Professor	Brandeis University
1983-1987	Associate Professor	Boston University
1980-81	Postdoctoral Fellow	Yale University
1976-1983	Assistant Professor	Boston University

Other Professional Positions:

Year	Position/Title	Institution
2012-present	Research Associate	National Bureau of Economic Research

Major Committee and Association Memberships:

Year	Position/Title	Institution
2003-2007	Member	NIH/ National Center for Research Resources, Council
1994-1998	Member	National Institute of Mental Health Services Research Review Committee
1980-84	Member	National Institute of Mental Health Epidemiologic and Services Research Review Committee
2000-present	Member	National Academies of Science, Education and Medicine/Institute of Medicine
2003-2009	Board of Directors	International Health Economics Association

Major Editorial Positions:

2001-2011	Editor	<i>Journal of Health Economics</i>
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Awards and Honors:

Year	Name of Award
2018	Victor Fuchs Award from the American Society of Health Economics for Lifetime Contributions to the Field of Health Economics
2016	Article of the Year, <i>International Journal of the Economics of Business</i>
2014	National Institute for Health Care Management Paper of the Year
2008	National Institute for Health Care Management Paper of the Year
2008	AcademyHealth Article of the Year Award
2008	Everett Mendelsohn Excellence in Mentoring Award
2006	Emily Mumford Medal for Distinguished Contributions to Social Science In Medicine
1997	Kenneth J. Arrow Award for Best Paper published in Health Economics
1994-1996	Investigator Award in Health Policy, Robert Wood Johnson Foundation
1991	Carl A. Taube Award for outstanding contributions to mental health services research, American Public Health Association
1989-1994, 1994-1999	Research Scientist Award, National Institute for Mental Health
1983	Elizur Wright Award for an outstanding contribution to the literature on risk and insurance (<i>Financing Psychotherapy</i>), American Risk and Insurance Association
1979	Abt Prize for Research on National Policy Issues

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Jacob Glazer and Thomas G. McGuire, (2017) *Models of Health Plan Payment and Quality Reporting*, World Scientific Press.

Thomas G. McGuire and Richard van Kleef, (eds.) "Health Plan Payment in Regulated Competition," Special Section of the *Journal of Health Economics*, Volume 56, December, 2017.

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Appendix B
Materials Relied Upon

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Attachment B
Materials Relied Upon

Legal

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Appendix C
Technical Memo re Mortality

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Appendix C Technical Memo re Mortality

In this appendix, I describe in Section I the basis for the quantification of deaths due to shipments. In Section II, I describe the methodology used to quantify the valuation of deaths.

I. Count of Number of Deaths

For the number of deaths due to shipments, I first begin with a raw count of opioid overdose deaths. This data is obtained directly from the CDC.¹ I then take these numbers and multiply by the share of harm due to shipments from the Cutler Report.²

II. Valuation of Deaths

I use the value of a statistical life to quantify the valuation of deaths.

Value of a Statistical Life (VSL)

The VSL is derived from an individual's willingness to pay (WTP) for a reduction in the risk of injury or death.³ WTP is estimated via revealed-preference studies using labor market data that measure the wage-risk tradeoff.⁴ WTP can also be directly measured using surveys that require respondents to express their risk-reduction preferences.⁵ An individual's risk-reduction WTP may vary based on factors such as risk-tolerance, preferences, age, health status, and other

¹ Centers for Disease Control and Prevention (CDC), WONDER data, Multiple Cause of Death data, available at <https://wonder.cdc.gov/controller/datarequest/D77>.

² See Cutler Report, Appendix III.I, Table I.4 for Approach 1 and Table I.5 for Approach 2.

³ For a recent review on the VSL literature, see L.A. Robinson and J.K. Hammit, "Valuing Reductions in Fatal Illness Risks: Implications of Recent Research," *Health Economics*, 25, 2016, pp. 1039-1052.

⁴ Examples of this approach include C.R. Scotton, "New risk rates, inter-industry differentials and the magnitude of VSL estimates," *Journal of Benefit-Cost Analysis*, 4(1), 2013, pp. 39-80.

⁵ A recent example of this approach is: T.A. Cameron and J.R. DeShazo, "Demand for Health Risk Reduction," *Journal Environmental Economics and Management*, 65, 2013, pp. 87-109.

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factors. For example, some studies find that the age-distribution of VSL takes the form of an inverted-U, implying that the VSL is highest for individuals in the 25-55 age range.⁶

The methodology I use for deriving a VSL is based on guidance from the Assistant Secretary for Planning and Evaluation (ASPE) of the U.S. Department of Human and Health Services (HHS), the federal agency responsible for evaluating health-related policies in the U.S.⁷ HHS recommends a VSL of \$9.3 million in 2014 dollars (without an age adjustment) as its main national estimate.⁸ For purposes of my report, I will use the central \$9.3 million estimate for 2014.

The Council of Economic Advisor's (CEA) recent report entitled "The Underestimated Cost of the Opioid Crisis," uses VSL-based estimates of the economic cost of death very similar to those used in my Report.⁹ The CEA selects \$9.6m in 2015 as its "middle" estimate, while showing results for higher and lower values of VSL as well.¹⁰

⁶ See J.K. Hammit, "Valuing Changes in Mortality Risk: Lives Saved versus Life Years Saved," *Review of Environmental Economics and Policy*, 1(2), 2007, pp. 228-240.

⁷ Office of the Assistant Secretary for Planning and Evaluation (ASPE), U.S. Department of Health and Human Services (HHS), "Guidelines for Regulatory Impact Analysis," 2016, available at https://aspe.hhs.gov/system/files/pdf/242926/HHS_RIAGuidance.pdf (hereafter HHS 2016 Guidelines). ASPE does not recommend adjusting the VSL for the age of the individual.

⁸ See HHS 2016 Guidelines, at p. 15. HHS also recommends sensitivity analyses and recommends sensitivity analyses using low and high VSL estimates of \$4.4 million and \$14.2 million, respectively. For simplicity I apply the central estimate in the text of my report. It is straightforward, if required, to inflate or deflate the estimates in the report up or down.

Other federal agencies also use VSL estimates to evaluate policy interventions. The methods proposed are broadly similar, but sometimes differ in the specific assumptions used. For example, the Department of Transportation recommends using a different deflator specification, but assumes income elasticity of VSL is 1.0, and base VSL is \$9.1 million in 2013 dollars. With their methodology, the VSL recommended for 2015 is \$9.4 million. See U.S. Department of Transportation (DOT), "Revised Departmental Guidance 2016: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses," 2016 (hereafter DOT 2016 Guidance).

The Environmental Protection Agency (EPA) guidelines are based on a review of the VSL literature. In particular, they aggregate 88 VSL estimates and derive a series of summary statistics of these numeric estimates using a variety of statistical approaches, settling on a central estimate of \$10.3 million for 2013 dollars. See U.S. Environmental Protection Agency, "Valuing Fatality Risk Reductions for Policy: A Meta-Analytic Approach," 2016 (hereafter EPA 2016).

⁹ Council of Economic Advisors, *The Underestimated Cost of the Opioid Crisis*, November 2017.

¹⁰ CEA, *op cit.*, pages 6-7.

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The national estimate for 2014 can be used as a basis for estimating the VSL for different years by applying a price-level adjustment and adapted to different geographic areas by applying an income adjustment. Specifically, the VSL for county *c* (Cuyahoga, Summit counties) and year *t* (2006, 2007, ..., 2016), VSL_{ct} , is estimated based on the HHS-recommended methodology, by applying equation (1):

$$VSL_{ct} = VSL_{2014} * \frac{CPI_t}{CPI_{2014}} * \left(1 + \left[\epsilon * \frac{(Y_{ct} - Y_{2014})}{(Y_{ct} + Y_{2014})/2} \right] \right) \quad (1)$$

Where

VSL_{2014} = National Value of Statistical Life in 2014

CPI_t = National Consumer Price Index for the year *t*

CPI_{2014} = National Consumer Price Index for 2014

ϵ = Income elasticity of Value of Statistical Life

Y_{2014} = National median income in 2014

Y_{ct} = Median income in county *c* at time *t*

The VSL_{2014} = \$9.3m is from the HHS recommendations as indicated above. The CPI for the years 2006 through 2016 is the Consumer Price Index for All Urban Consumers Current Series (CPI) from the Bureau of Labor Statistics.¹¹ The parameter ϵ for the income elasticity is assumed to be 1.0 following HHS recommendations, recommendations in line also with those of the Department of Transportation.¹² Assuming a relatively high value of the income elasticity in this context is conservative because the median income in the Bellwether communities is lower than the national average.¹³ The source of national and county median income is the Census Bureau's American Community Survey 1-year estimates.¹⁴

¹¹ CPI data is available from <https://www.bls.gov/cpi/data.htm>. I utilized the All Urban Consumer Current Series CUSR0000SAO. HHS recommends using the CPI to adjust for inflation. See page 38 of the HHS 2016 Guidelines.

¹² DOT 2016 Guidance, p. 9. Note that the EPA recommends a value of 0.7, with a range of 0.1 to 1.7 (EPA 2016, p. 10).

¹³ A smaller income elasticity of demand would result in a higher estimated VSL in the Bellwether communities.

¹⁴ U.S. Census Bureau, *2006-2016 American Community Survey 1-Year Estimates (Subject Table S1901)*. Available from <https://factfinder.census.gov/>.

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The interpretation of the VSL for a county in a year from (1) is the median valuation a member of the county would put on the loss of life, measured in current dollars. Expression (1) adjusts the national figure for VSL in 2014 for changes in price levels between years and differences in income between counties. The ratio of the CPIs adjusts for prices. In years prior to 2014, for example, this ratio will be less than one, tending to factor down the VSL. The product of the elasticity ϵ and the percentage difference in the county-year specific income and the national base year for 2014 adjusts the VSL for changes in valuation that would accompany higher incomes. The assumption of $\epsilon = 1.0$ means that the increase in valuation of the VSL moves in proportion to income. A one percent increase in income leads to a one percent increase in the VSL.

The resulting VSL for each Bellwether county for each year is in Tables C.1a and C.1b. Values from these tables are multiplied by the deaths due to shipments as determined by Professor Cutler. Tables C.2a and C.2b show the results of this calculation for Approach 1 and Tables C.3a and C.3b for Approach 2. Tables C.2a and C.2b are replicated in the body of my Report as Tables 5a and 5b.

Table C.1a
Value of Statistical Life for Cuyahoga County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CPI/CPI(2014)	0.85	0.88	0.91	0.91	0.92	0.95	0.97	0.98	1.00	1.00	1.01
Adjusted VSL (\$m)	\$7.92	\$8.15	\$8.46	\$8.43	\$8.57	\$8.84	\$9.02	\$9.15	\$9.30	\$9.31	\$9.43
Median Income	41,522	44,358	44,199	40,101	41,347	41,530	41,880	43,501	44,016	45,297	46,601
VSL (\$m)	\$5.90	\$6.60	\$6.82	\$5.99	\$6.35	\$6.58	\$6.80	\$7.24	\$7.46	\$7.74	\$8.10

Table C.1b
Value of Statistical Life for Summit County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CPI/CPI(2014)	0.85	0.88	0.91	0.91	0.92	0.95	0.97	0.98	1.00	1.00	1.01
Adjusted VSL	\$7.92	\$8.15	\$8.46	\$8.43	\$8.57	\$8.84	\$9.02	\$9.15	\$9.30	\$9.31	\$9.43
Median Income	44,747	47,333	49,411	46,974	45,593	46,429	48,798	49,232	50,365	51,309	52,036
VSL (\$m)	\$6.49	\$7.13	\$7.76	\$7.31	\$7.17	\$7.56	\$8.16	\$8.36	\$8.71	\$8.89	\$9.14

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Table C.2a
Value of Statistical Life for Cuyahoga County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	104	87	111	92	138	185	191	223	234	245	504	2,114
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Opioid Deaths Due to Shipments	51	44	57	48	75	107	127	166	189	214	457	1,535
VSL (\$mil)	\$5.9	\$6.6	\$6.8	\$6.0	\$6.3	\$6.6	\$6.8	\$7.2	\$7.5	\$7.7	\$8.1	
Valuation (\$mil)	\$302	\$289	\$387	\$289	\$478	\$702	\$864	\$1,199	\$1,413	\$1,655	\$3,702	\$11,279

Table C.2b
Value of Statistical Life for Summit County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	25	31	21	23	45	34	60	56	105	135	269	804
Share of Harm Due to Shipments	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Opioid Deaths Due to Shipments	12	16	11	12	25	20	40	42	85	118	244	623
VSL (\$mil)	\$6.5	\$7.1	\$7.8	\$7.3	\$7.2	\$7.6	\$8.2	\$8.4	\$8.7	\$8.9	\$9.1	
Valuation (\$mil)	\$80	\$111	\$83	\$88	\$176	\$148	\$326	\$348	\$740	\$1,048	\$2,229	\$5,377

Table C.3a
Value of Statistical Life for Cuyahoga County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	104	87	111	92	138	185	191	223	234	245	504	2,114
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Opioid Deaths Due to Shipments	87	75	95	71	107	152	161	192	208	223	468	1,838
VSL (\$mil)	\$5.9	\$6.6	\$6.8	\$6.0	\$6.3	\$6.6	\$6.8	\$7.2	\$7.5	\$7.7	\$8.1	
Valuation (\$mil)	\$514	\$492	\$645	\$425	\$681	\$1,001	\$1,091	\$1,387	\$1,554	\$1,726	\$3,790	\$13,306

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Table C.3b
Value of Statistical Life for Summit County
Using National 2014 VSL of \$9.3m, National Median Income of \$53,657
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	25	31	21	23	45	34	60	56	105	135	269	804
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Opioid Deaths Due to Shipments	21	27	18	18	35	28	50	48	93	123	250	711
VSL (\$mil)	\$6.5	\$7.1	\$7.8	\$7.3	\$7.2	\$7.6	\$8.2	\$8.4	\$8.7	\$8.9	\$9.1	
Valuation (\$mil)	\$136	\$189	\$139	\$130	\$251	\$211	\$412	\$402	\$814	\$1,093	\$2,282	\$6,059

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Appendix D
Technical Memo re Prevalence of OUD and the Share Attributable to Shipments

Appendix D

Technical Memo re Prevalence of OUD and the Share Attributable to Shipments

In this appendix, I describe the basis for the estimates of the prevalence of OUD and the quantification of individuals with OUD due to shipments. In Appendix H, I describe the methodology to value the excess health costs for individuals with OUD.

Count of Number of Individuals with OUD

The morbidity analysis calls for time series data on OUD rates. There are two problems in applying OUD rates published by National Survey on Drug Use and Health (NSDUH). First, it is generally recognized that NSDUH rates understate OUD; second, NSDUH changed its Rx drug question sequence and show-cards in 2015, leaving Rx OUD data for 2015-17 not fully comparable to data from earlier years. This appendix outlines an approach to constructing estimates of OUD rates between 2006-16. The approach follows the methodology used by Pitt *et al.* (2018)¹ for adjusting for the downward bias in NSDUH HUD and Rx OUD rates in 2016 and then uses trends in these NSDUH rates to create the time series. To adjust for the changes in NSDUH OUD definitions in 2015, I infer the 2014/2015 change based on changes in surrounding years.

Description of Pitt *et al.* Correction to OUD rate

The Pitt *et al.* (2018) supplement identifies two national measurements of 2016 OUD as inputs into the model – severe prescription opioid use disorder (SOUD, 0.77%) and severe heroin use disorder (SHUD, 0.51%).² Adding the two together yields a combined 2016 national OUD rate of 1.28%.³ The derivations of these rates are described below and the Pitt *et al.* discussion of this derivation is available in Attachment D.A at the end of this appendix.

¹ A.L. Pitt, K. Humphreys and M.L. Brandeau, “Modeling Health Benefits and Harms of Public Policy Responses to the US Opioid Epidemic,” *American Journal of Public Health (AJPH)*, Open Themed Research, 108(10), October 2018, pp. 1394-1400.

² *Ibid.*, Supplement, Table A. The SHUD rate excludes individuals with SHUD that did not first have SOUD.

³ Pitt *et al.*, *op. cit.*, calculation of SOUD does not include individuals who also have SHUD (these individuals would fall into the SHUD bucket), therefore the two numbers can be added together to get an overall OUD rate.

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- The 2016 SOUD rate of 0.77% rate is estimated based on reported prescription overdose deaths and the likelihood of overdose death. This estimation requires the following inputs, some of which Pitt *et al.* calculate from available data and some of which are assumed: (1) reported prescription overdose deaths; (2) proportion of SOUD enrolled in Medication-Assisted Treatment (MAT); (3) overdose mortality risk when not enrolled in MAT; and (4) relative overdose mortality risk reduction when enrolled in MAT.⁴
- The 2016 SHUD rate of 0.51% is calculated as follows:
 - Uses RAND estimate of 1 million people with SHUD in 2010.⁵
 - Brought forward to 2016 using the growth in the NSDUH HUD rate between 2010 and 2016 (64%).⁶
 - Pitt *et al.* SHUD rate is calculated as the number of people with SHUD expressed as a share of the U.S. population ages 12 and above.

⁴ Pitt *et al.*, *op. cit.*, Supplement, pp. S4-S5 and Table A.

⁵ RAND Corporation, “What America’s Users Spend on Illegal Drugs: 2000-2010,” prepared for U.S. Office of National Drug Control Policy, February 2014, p. 23.

⁶ Pitt *et al.*, *op. cit.*, note that they use the growth rate between 2010 and 2015 but based on the NSDUH data it appears they use the growth rate between 2010 and 2016. Pitt *et al.*, *op. cit.* incorporate other adjustments that are specific to their model but unrelated to constructing an OUD time series for my purposes.

Table D.1 below replicates the Pitt *et al.* calculation of SHUD.

Table D.1
Replication of Pitt *et al.* Calculation of 2016 National SHUD Rate

[A]	2010 Daily or Near-Daily Users of Heroin (millions)	1.0
[B]	2010 US Population 12+ (millions)	259.9
[C]	2010 SHUD Rate Based on Pitt et al.	0.38%
[D]	Growth in NSDUH rate of HUD 2010-2016	63.95%
[E]	2016 SHUD Rate Based on Pitt et al.	0.63%

Sources and Notes:

[A] Rand (2014), p. 23. Daily or near-daily users of heroin 12+ years of age are those who use 21+ days / month.

[B] Census Bureau Annual Estimates of the Resident Population by Single Year of Age and Sex for the United States, States, and Puerto Rico Commonwealth: April 1, 2010 to July 1, 2017 (pepsyasex).

[C]=[A]/[B]. 2010 Severe Heroin Use Disorder (SHUD) rate, based on Pitt et al. methodology. Pitt et al. (2018) Supplement, pp. S2-S3.

[D] NSDUH.

[E]=[C]*(1+[D]). Calculation of 2016 SHUD rate based on Pitt et al. methodology. Pitt et al. (2018) Supplement, pp. S2-S3.

Calculation of National OUD Time Series (2006-2016)

The national OUD time series for 2006-16 uses the Pitt *et al.* estimates of Soud and SHUD for 2016 as the starting point and then brings these rates backwards and forwards using trends in NSDUH rates of heroin use disorder and prescription opioid use disorder. That is, the calculation reflects the assumption that the trends in the adjusted rate (as estimated by Pitt *et al.*) follows trends in published SHUD rates. These calculations are summarized in Table D.2 and are described in more detail below.

Calculation of HUD Time Series (2006-2016)

The national SHUD rate in 2010 (0.38%) reflects the Pitt *et al.* estimate of 1 million daily or near-daily users of heroin expressed as a share of the 12+ population. I then multiply it by the

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rate of growth in the NSDUH HUD rate between 2010 and each of the other years in 2006-16 to estimate a national rate for this period. See rows [A]-[C] in Table D.2, below.

Calculation of Prescription Opioid Use Disorder Time Series (2006-2016)

A times series estimate of adjusted rates of Soud starts with Pitt *et al.*'s estimate of a 2016 rate of 0.77%. This can be extrapolated backward and forward using the NSDUH published rate for prescription Opioid Use Disorder. However, the NSDUH survey methodology for Prescription Opioid Use Disorder changed in 2015 and NSDUH did not publish an adjustment factor that identifies the impact of the definitional change. (There was no change to NSDUH's definition of HUD.) Attachment D.B to this appendix explains the changes to NSDUH's definitions. To adjust for this change, I assume that the change from 2014-15 is the average of the changes between 2013-14 and 2015-16. Using estimates of changes in annual rates calculated in this way, I construct estimates for 2006-16 using Pitt's 2016 estimates of Soud as a starting point.

Calculation of OUD Time Series (2006-2016)

The estimates of SHUD and Soud are reported in Table D.2. The OUD time series can be calculated as the sum of these series.

Table D.2
Calculation of Adjusted OUD Rate Based on Pitt *et al.* Methodology

Source	Series	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
[A]	NSDUH HUD Rate	0.12%	0.09%	0.12%	0.16%	0.14%	0.18%	0.19%	0.20%	0.23%	0.22%	0.24%
[B]	% Change from 2010	-16.9%	-40.1%	-19.1%	13.2%	0.0%	25.8%	28.6%	36.1%	57.0%	51.5%	64.0%
[C]	Adjusted HUD Rate	0.32%	0.23%	0.31%	0.44%	0.38%	0.48%	0.49%	0.52%	0.60%	0.58%	0.63%
[D]	NSDUH Pain Reliever Use Disorder Rate	0.66%	0.70%	0.68%	0.71%	0.76%	0.72%	0.81%	0.74%	0.71%	0.77%	0.69%
[E]	Change from previous year (2015 imputed)		6.3%	-3.5%	4.3%	7.7%	-6.0%	12.9%	-8.7%	-3.9%	-7.1%	-10.2%
[F]	Adjusted Pain Reliever Use Disorder Rate	0.86%	0.92%	0.88%	0.92%	0.99%	0.93%	1.05%	0.96%	0.92%	0.86%	0.77%
[G]	Adjusted OUD Rate	1.18%	1.15%	1.19%	1.36%	1.38%	1.42%	1.55%	1.48%	1.53%	1.44%	1.40%

Sources and Notes:

Bolded and boxed values are inputs from Pitt et al. (2018). For derivation of [C] 2010, see Table 1.

[A] NSDUH.

[B] Percentage difference in [A] from 2010 rate.

[C] Based on Pitt et al. (2018) methodology. Adjusted HUD rate in 2010 of 0.38% based on Rand (2014) study. See Table 1. Other years calculated from 2010 rate based on trend in NSDUH HUD rate.

[D] NSDUH.

[E] Percentage change in [D] from previous year. Percentage change from 2014 to 2015 calculate as the simple average of the 2013/2014 and 2015/2016 percentage changes.

[F] 2016 value from Pitt et al. (2018). Other years calculated based on trend in NSDUH rates of pain reliever use disorder, with 2015 imputation. (Row [E]).

[G]=[C]+[F].

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Benchmarking Against Recent Publications

A recent study from Barocas *et al.* (2018) estimates the prevalence of OUD in Massachusetts using an epidemiological “capture-recapture” analysis using data from six administrative databases of public health data.⁷ This study estimates prevalence of OUD in Massachusetts of 2.72% to 4.60% between 2011 and 2015. Over this same period, based on the Pitt *et al.* methodology, I calculated adjusted national OUD rates of 1.42% to 1.55%. See Table D.2 above. Available data indicate that Ohio had slightly higher rates of OUD and opioid-related mortality than did Massachusetts during this period.⁸ Based on Barocas *et al.*, the results reported in Table D.2 are conservative.

Number of Individuals with OUD Attributable to Opioid Shipments

Based on the above prevalence rates, I calculate the number of individuals with OUD attributable to opioid shipments in each year from 2006 through 2016.⁹ The calculation of persons with OUD due to shipments for each of the counties is shown below in Tables D.3a and D.3b for Approach 1 which also appears in Tables 7a and 7b of the Report. Tables D.4a and D.4b below show the results for Approach 2.

⁷ J.A. Barocas, *et al.*, “Estimated Prevalence of Opioid Use Disorder in Massachusetts, 2011–2015: A Capture–Recapture Analysis,” *American Journal of Public Health (AJPH)*, Open Themed Research, 108(12), December 2018, pp. 1675-181.

⁸ In 2012-13, the NSDUH OUD rate for Ohio was 1.10% and for Massachusetts was 1.07% (<https://rdas.samhsa.gov/>). In 2011-2015 the age-adjusted opioid-related mortality rate per 100,000 in Ohio was 16.4 and in Massachusetts was 14.8. Source: CDC Multiple Causes of Death data, accessed on CDC Wonder.

⁹ Prevalence of OUD from above. County Population from U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (NCHS), Bridged Race Population Estimates. Share of Harm Due to Shipments from Cutler Report, Appendix III.I, Tables I.4 and I.5.

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Table D.3a
Persons with OUD Due to Opioid Shipments, Cuyahoga County, Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	12,040.8
Person-years with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	
Share of Harm Due to Shipments[3]	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Person-years with OUD Due to Opioid Shipments (000s)	6.49	6.40	6.73	7.82	8.22	8.89	11.19	11.99	13.42	13.62	13.73	108.52

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.4

Table D.3b
Persons with OUD Due to Opioid Shipments, Summit County, Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Person-years with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	
Share of Harm Due to Shipments[3]	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Person-years with OUD Due to Opioid Shipments (000s)	2.68	2.67	2.82	3.29	3.48	3.79	4.78	5.13	5.76	5.86	5.92	46.18

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.4

Table D.4a
Persons with OUD Due to Opioid Shipments, Cuyahoga County, Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	12,040.8
Person-years with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	
Share of Harm Due to Shipments[3]	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Person-years with OUD Due to Opioid Shipments (000s)	11.04	10.89	11.23	11.51	11.72	12.68	14.14	13.87	14.76	14.21	14.05	140.12

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.5

Table D.4b
Persons with OUD Due to Opioid Shipments, Summit County, Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Person-years with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	
Share of Harm Due to Shipments[3]	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Person-years with OUD Due to Opioid Shipments (000s)	4.57	4.54	4.71	4.84	4.96	5.40	6.04	5.94	6.34	6.12	6.06	59.50

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.5

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Attachment D.A
Pitt Discussion of Derivation of Rate of SOUD and SHUD for 2016

Parameter values (Pitt Supplement, Table A)

Severe opioid use disorder prevalence	0.77%	Assumed ^{22,23}
Severe heroin use disorder prevalence	0.51%	Calculated ¹⁴⁻¹⁷

Discussion of derivation of SOUD and SHUD rates (Pitt Supplement, pp. S3-S4)

The National Survey on Drug Use and Health (NSDUH)¹⁴ tends to underreport opioid use disorder due to omission of some key populations (e.g., homeless, incarcerated) that are known to have high rates of illicit drug use, so we used estimates from RAND Corporation¹⁵ to estimate SHUD prevalence. Based on the RAND data, we estimated that 1 million people had SHUD in 2010 (this is the number of individuals with 21+ days of use per month). Because the RAND data ends with 2010, we projected to 2016 prevalence using the 64% growth in heroin use disorder reported by NSDUH from 2010 to 2015.¹⁴ This yielded an estimate of 1.7 million people with SHUD in 2016. We adjusted this total to have the model reflect only the ~80% of individuals with SHUD who first had SOUD,^{16,17} Though the monthly prevalence of MAT among individuals with SHUD is not reported, studies indicate that rates of MAT are low relative to the population with abuse and/or dependence.¹⁸⁻²⁰ We approximated the percentage of individuals with SHUD who are enrolled in MAT (“SHUD in MAT”) based on expert opinion (K. Humphreys).

NSDUH and the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III)²¹ report rates of prescription opioid dependence and use trends; however, prevalence of severe opioid use disorder is not reported. Additionally, these surveys suffer from underreporting in key populations of relevance to the epidemic. We therefore estimated SOUD prevalence based on reported prescription opioid overdose deaths, adjusted for underreporting, and the estimated likelihood of overdose death. We performed the adjustment for underreporting by assuming that the actual number of prescription opioid-related deaths was 24% greater²² than the total opioid deaths minus deaths from illicit opioids (heroin and synthetic opioids other than methadone) reported by the Centers for Disease Control and Prevention.²³ Because there is no

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reliable data on the risk of overdose death from Soud, we estimated it assuming a 0.5 relative risk of overdose mortality for Soud relative to SHUD. (We describe calculation of the SHUD overdose mortality rate in the Mortality subsection of S1.4). For individuals with Soud in MAT, mortality risk is reduced by half.²⁴ We solved the equation below to obtain an estimate of the size of the total Soud population (“Chronic pain Soud with Rx”, “Pain-free Soud with Rx”, “Soud without Rx”, “Soud in MAT”). Based on expert opinion, we assumed that a lower percentage of individuals with Soud than with SHUD enroll in MAT (K. Humphreys).

$$\frac{\text{Soud overdose deaths}}{\text{Soud population size}}$$

$$= \text{Soud overdose mortality risk not in MAT}$$

$$* (1 - \text{proportion Soud enrolled in MAT})$$

$$+ \text{Soud overdose mortality risk not in MAT} * \text{risk reduction in MAT}$$

$$* \text{proportion Soud enrolled in MAT}$$

where

$$\text{Soud overdose mortality risk not in MAT}$$

$$= \text{SHUD overdose mortality risk not in MAT}$$

$$* \text{relative risk of mortality in Soud vs. SHUD}$$

Given the total Soud population, the percent in MAT, and the number of individuals in the “Chronic pain Soud with Rx” and “Pain-free Soud with Rx” compartments, we determined the size of the “Soud in MAT” and “Soud without Rx” populations.

Attachment D.B**Change in NSDUH Methodology for Measuring Prescription Opioid Use Disorder in 2015**

Starting with the 2015 NSDUH survey, a number of changes were made to the NSDUH questionnaire and data collection process with the intent of improving the quality of the data collected.¹⁰ These changes affected the questions and data collection process for prescription drugs, among other topics, but not heroin.¹¹ NSDUH notes that where estimates are no longer comparable, such as with prescription drugs, they “are assumed to have ‘broken’ trends and to begin new baselines in 2015.”¹²

Below is a summary of the changes for prescription drugs (which includes prescription opioids).¹³

2.6 Prescription Drugs

The prescription drug questions were redesigned for the 2015 NSDUH. Prior to 2015, NSDUH focused on estimates of prescription drug misuse (previously called "nonmedical use") at the category level (pain relievers, sedatives, tranquilizers, and sedatives), but did not collect many details regarding the use or misuse of many specific prescription drugs in the past year. Questions about lifetime misuse of most specific prescription drugs were asked only for the lifetime period. Questions about any use of prescription drugs (as opposed to just misuse) also were not asked. Collecting more detailed and complete information on use, misuse, and recent initiation of a comprehensive set of specific prescription drugs was determined to be more useful for policy and research purposes, partly due to public health concerns about recent increases in addiction, overdose, and death involving prescription drugs, particularly prescription pain relievers. To address these priorities, the following changes were implemented in 2015:

- The focus of the prescription drug questions in 2015 was changed to a 12-month reference period instead of the lifetime reference period that was used in prior NSDUH questionnaires. Detailed information was collected regarding past year use and misuse of several specific prescription drugs and overall drug categories (pain relievers,

¹⁰ NSDUH, “2015 National Survey on Drug Use and Health - Summary of the Effects of the 2015 NSDUH Questionnaire Redesign: Implications for Data Users”, June 2016, p. 1.

¹¹ NSDUH, “2015 National Survey on Drug Use and Health - Summary of the Effects of the 2015 NSDUH Questionnaire Redesign: Implications for Data Users”, June 2016, p. 2.

¹² NSDUH, “2015 National Survey on Drug Use and Health - Summary of the Effects of the 2015 NSDUH Questionnaire Redesign: Implications for Data Users”, June 2016, p. 1.

¹³ NSDUH, “2015 National Survey on Drug Use and Health - Summary of the Effects of the 2015 NSDUH Questionnaire Redesign: Implications for Data Users”, June 2016, pp. 4-5.

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tranquilizers, stimulants, and sedatives), but detailed questions on lifetime misuse of specific prescription drugs were not included.

- Questions about any use of prescription drugs (instead of just misuse) during the past year were added.
- The definition of misuse was revised to use of a drug "in any way a doctor did not direct you to use it [or them]" in order to focus on the behavioral components of misuse. Prior to 2015, respondents were asked about the use of prescription drugs that were not prescribed for respondents (i.e., a behavior) or that respondents took only for the experience or feeling that the drugs caused (i.e., a motivation). Examples of behaviors of misuse that were presented to respondents in 2015 included (a) use without a prescription of the respondent's own; (b) use in greater amounts, more often, or longer than told to take a drug; or (c) use in any other way a doctor did not tell respondents to take a drug.
- Electronic images of prescription drugs replaced the hard-copy "pill cards" that were shown to respondents, and examples other than pills were shown (e.g., a picture of morphine in liquid form for injection and pictures of patches for delivering certain drugs through the skin).
- Prescription drugs that previously were included elsewhere in the questionnaire (i.e., Adderall[®] and Ambien[®]) were moved to the appropriate prescription drug module. As noted earlier, methamphetamine was also moved to its own section that was separate from prescription stimulants.
- New information was collected on the specific ways in which respondents misused prescription drugs (e.g., without a prescription of the respondent's own, use in greater amounts than prescribed).
- New detailed information was collected on the motivations for misuse.

These changes will result in new baselines for 2015 for all prescription drug measures, including measures for any prescription psychotherapeutic drug and categories of psychotherapeutic drugs (pain relievers, tranquilizers, stimulants, and sedatives). Specifically, new baselines will begin in 2015 for measures of use and misuse, past year initiation of prescription drug misuse, and prescription drug use disorders. Additionally, due to the differences in the way lifetime prescription drug misuse was measured in 2015, it appears that lifetime misuse measures are underreported compared with prior years. Therefore, lifetime prescription drug misuse measures will not be reported, including the reporting of trends.

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Appendix E
Technical Memo re Neonatal Abstinence Syndrome (NAS)

Appendix E

Technical Memo re Neonatal Abstinence Syndrome (NAS)

In Section I, I describe a methodology for estimating the number of cases of neonatal abstinence syndrome (NAS) in the Bellwether counties attributable to opioid shipments. In Section II, I estimate the excess hospital costs associated with those cases.

I. Estimating the Number of Neonatal Abstinence Syndrome Cases

The data used in this analysis are publicly available, and collected and summarized by the Ohio Department of Health (ODH) on the incidence and cost of all births and of NAS births in Ohio.¹ Reports from 2006-2015 and 2017 provide 1) the number of NAS hospitalizations in Ohio and 2) the average hospital charges for all births and NAS births.² These data are all statewide. An additional report for 2017 provides the number of NAS cases by county of residence within Ohio for 2016 and 2017, separately, and for 2013-2017 in total.³

The number of NAS discharges in the state of Ohio between 2006 and 2017 is reported in row 1 of Table E.1 below.

The far-right columns of rows 4 and 5 report county-level NAS incidences for 2016, 2017 and 2013-2017. The Cuyahoga and Summit shares of the total Ohio cases of NAS for 2016, 2017 and 2013-2017 are calculated in rows 2 and 3. The number of county-level NAS cases in 2013-2015 are estimated by subtracting the 2016-2017 cases from the 2013-2017 case total and distributing these cases equally across the three years. For NAS case estimates in 2006-2012, I

¹ https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/violence-injury-prevention-program/resources/nas_hospital_reporting_in_ohio.

² See Ohio Department of Health, "Neonatal Abstinence Syndrome (NAS) in Ohio, 2006-2015 Report," Tables 1A and 1D; "2017 Ohio Neonatal Abstinence Syndrome Report" available at https://odh.ohio.gov/wps/wcm/connect/gov/73b5602a-eb7a-4967-92ba-113de136371d/2017%2BNAS%2BData%2BTable%2B10.25.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-73b5602a-eb7a-4967-92ba-113de136371d-muuj4xU.

³ Ohio Department of Health, "2017 Ohio Neonatal Abstinence Syndrome County Report," available at https://odh.ohio.gov/wps/wcm/connect/gov/4cad708c-ba99-4b8b-b425-01cfef119c5d/2017+NAS+County+Table+12.3.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-4cad708c-ba99-4b8b-b425-01cfef119c5d-muueFzr.

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use the 2013-2017 Cuyahoga (Summit) share of total Ohio cases to approximate the number of cases in Cuyahoga (Summit). The results of these estimations are in rows 2 and 3.

To estimate the share of opioid-related NAS cases attributable to opioid-shipments, I multiply the number of opioid-related NAS cases in rows 2 and 3 by the share of harm attributable to all shipments estimated by Professor Cutler.⁴ Based on Approach 1, this analysis estimates that there are 609 cases of opioid-related NAS attributable to shipments in Cuyahoga County from 2006-2016 and 430 cases in Summit County during the same period. The same analysis using Approach 2 is presented Table E.2.

Table E.1
Estimates of NAS Cases in Bellwether Counties Attributable to Opioid Shipments
Approach 1

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2013-2017
Ohio NAS and Drug Abuse/Dependence Statistics														
[1]	NAS Discharges ^[A,C]	305	369	477	715	953	1,172	1,482	1,717	1,919	2,174	2,223	1,935	9,968
County-level NAS Statistics														
[2]	NAS - Cuyahoga ^[B]	19	23	30	45	60	74	94	117	117	117	141	137	629
[3]	NAS - Summit ^[B]	13	16	20	31	41	50	63	89	89	89	89	71	426
[4]=[2]/[1]	Cuyahoga Share of Ohio NAS											6.3%	7.1%	6.3%
[5]=[3]/[1]	Summit Share of Ohio NAS											4.0%	3.7%	4.3%
[6]	Share of Harm Due to Shipments ^[D]	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%		
														2006-2016
[7]=[2]*[6]	NAS Cases Due to Opioid Shipments - Cuyahoga	9	12	15	24	33	43	62	87	95	102	128		609
[8]=[3]*[6]	NAS Cases Due to Opioid Shipments - Summit	6	8	10	16	22	29	42	66	72	77	81		430

Sources:

- [A] 2017 Ohio Neonatal Abstinence Syndrome Report, https://odh.ohio.gov/wps/wcm/connect/gov/73b5602a-eb7a-4967-92ba-113de136371d/2017%2BNAS%2BData%2BTable%2B10.25.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGK0N0JO00Q9DDDDM3000-73b5602a-eb7a-4967-92ba-113de136371d-muuj4xU
- [B] 2017 Ohio Neonatal Abstinence Syndrome County Report, https://odh.ohio.gov/wps/wcm/connect/gov/4cad708c-ba99-4b8b-b425-01cfe119c5d/2017+NAS+County+Table+12.3.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGK0N0JO00Q9DDDDM3000-4cad708c-ba99-4b8b-b425-01cfe119c5d-muueFzr
- [C] Neonatal Abstinence Syndrome (NAS) in Ohio, 2006-2015 Report, Ohio Department of Health
- [D] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.4

Notes: The NAS cases reported by ODH reflect ICD-9 CM code 779.5 for 2006 through September 30, 2015 and ICD-10-CM code P96.1 for October 1, 2016 through 2017. The ICD-9 or ICD-10 codes could appear in the primary or secondary diagnosis fields. The number of NAS cases in Cuyahoga and Summit counties in 2006-2012 estimated using 2013-2017 county share of NAS in Ohio (6.3% for Cuyahoga and 4.3% for Summit) and the total number of NAS cases in Ohio (row [1]). The number of NAS cases in 2013-2015 are set equal to the number of 2013-2017 cases, by county, minus the county totals in 2016-2017, split evenly across years.

⁴ See Cutler Report, Appendix III.I, Tables I.4 and I.5.

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Table E.2
Estimates of NAS Cases in Bellwether Counties Attributable to Opioid Shipments
Approach 2

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2013-2017
Ohio NAS and Drug Abuse/Dependence Statistics														
[1]	NAS Discharges ^[A,C]	305	369	477	715	953	1,172	1,482	1,717	1,919	2,174	2,223	1,935	9,968
County-level NAS Statistics														
[2]	NAS - Cuyahoga ^[B]	19	23	30	45	60	74	94	117	117	117	141	137	629
[3]	NAS - Summit ^[B]	13	16	20	31	41	50	63	89	89	89	89	71	426
[4]=[2]/[1]	Cuyahoga Share of Ohio NAS											6.3%	7.1%	6.3%
[5]=[3]/[1]	Summit Share of Ohio NAS											4.0%	3.7%	4.3%
[6]	Share of Harm Due to Shipments ^[D]	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%		
														2006-2016
[7]=[2]*[6]	NAS Cases Due to Opioid Shipments - Cuyahoga	16	20	26	35	47	61	79	101	104	107	131		725
[8]=[3]*[6]	NAS Cases Due to Opioid Shipments - Summit	11	14	17	24	32	41	53	76	79	81	83		510

Sources:

- [A] 2017 Ohio Neonatal Abstinence Syndrome Report, https://odh.ohio.gov/wps/wcm/connect/gov/73b5602a-eb7a-4967-92ba-113de136371d/2017%2BNAS%2BData%2BTable%2B10.25.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00Q9DDDDM3000-73b5602a-eb7a-4967-92ba-113de136371d-muuj4xU
- [B] 2017 Ohio Neonatal Abstinence Syndrome County Report, https://odh.ohio.gov/wps/wcm/connect/gov/4cad708c-ba99-4b8b-b425-01cfe119c5d/2017+NAS+County+Table+12.3.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00Q9DDDDM3000-4cad708c-ba99-4b8b-b425-01cfe119c5d-muueFzr
- [C] Neonatal Abstinence Syndrome (NAS) in Ohio, 2006-2015 Report, Ohio Department of Health
- [D] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.5

Notes: The NAS cases reported by ODH reflect ICD-9 CM code 779.5 for 2006 through September 30, 2015 and ICD-10-CM code P96.1 for October 1, 2016 through 2017. The ICD-9 or ICD-10 codes could appear in the primary or secondary diagnosis fields.

The number of NAS cases in Cuyahoga and Summit counties in 2006-2012 estimated using 2013-2017 county share of NAS in Ohio (6.3% for Cuyahoga and 4.3% for Summit) and the total number of NAS cases in Ohio (row [1]). The number of NAS cases in 2013-2015 are set equal to the number of 2013-2017 cases, by county, minus the county totals in 2016-2017, split evenly across years.

II. Valuation of Excess Health Costs for NAS

The next step in this analysis is to estimate the cost for the NAS cases attributable to shipments. Row 3 of Table E.3 provides the average hospital charges for an NAS case in Ohio from 2006-2016. Row 4 provides the average hospital charges for a birth in Ohio, using all births to Ohio residents from 2006-2016.⁵ Both estimates are based on ODH statewide data. The difference between these two charge amounts is the excess hospital charge resulting from NAS.⁶

Because the ODH reports hospital charges, I use net revenue-to-charge ratios from the American Hospital Association to approximate hospital costs. The American Hospital

⁵ This data for the average charges for all births will include charges for NAS births and therefore is a conservative comparison.

⁶ The average charges reflect charges billed by the hospital ("2017 Ohio Neonatal Abstinence Syndrome Report" Ohio Department of Health).

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Association publishes aggregate data on gross hospital charges and net patient revenues by state. I use that data for the state of Ohio, reproduced in rows 6 and 7 of Table E.3, to estimate the revenue to charge ratio for Ohio hospitals and I use this ratio to estimate the excess costs required to treat NAS patients.⁷ The average excess cost for a case of NAS is reported in row 9 of Table E.3. Average excess costs for NAS are multiplied by the number of cases in Cuyahoga and Summit counties to estimate total excess hospital costs due to NAS resulting from opioid shipments (rows 10 and 11). Table E.3 below reports the total estimated cost of NAS attributable to shipments, under Approach 1. These costs were \$9.4 million in Cuyahoga County and \$6.6 million in Summit County.⁸ The same analysis using Approach 2 is presented in Table E.4.

Table E.3
Hospital Cost Estimates for NAS Attributable to Opioid Shipments
Approach 1

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
[1]	Opioid-related NAS Cases - Cuyahoga	9	12	15	24	33	43	62	87	95	102	128	609
[2]	Opioid-related NAS Cases - Summit	6	8	10	16	22	29	42	66	72	77	81	430
[3]	Average Charge for NAS in Ohio Hospitals ^[A]	39,561	59,033	59,580	72,158	64,911	59,847	57,813	61,469	68,666	61,241		
[4]	Average Charge for a Birth in Ohio Hospitals ^[A]	6,838	7,870	8,660	9,680	10,336	11,452	12,977	13,604	14,570	15,494		
[5]=[3]-[4]	Excess Charges for NAS Births	32,723	51,163	50,920	62,478	54,575	48,395	44,836	47,865	54,096	45,747	44,903	
[6]	Ohio Hospital Gross Patient Revenues (millions) ^[B]	64,339	69,105	77,003	85,584	93,353	99,617	108,810	117,265	125,847	134,927		
[7]	Ohio Hospital Net Patient Revenues (millions) ^[B]	25,333	26,372	28,423	30,514	31,793	32,381	35,605	37,124	39,137	41,324		
[8]=[7]/[6]	Net Revenue to Gross Charge Ratio	39.4%	38.2%	36.9%	35.7%	34.1%	32.5%	32.7%	31.7%	31.1%	30.6%	29.8%	
[9]=[5]*[8]	Excess Hospital Costs Due to NAS	12,885	19,525	18,795	22,276	18,587	15,731	14,671	15,153	16,823	14,011	13,397	
[10]=[1]*[9]	Total Cost of NAS Due to Shipments - Cuyahoga	122,019	228,920	288,999	526,513	609,856	670,388	912,893	1,316,789	1,592,307	1,430,664	1,712,847	9,412,195
[11]=[2]*[9]	Total Cost of NAS Due to Shipments - Summit	82,639	155,040	195,729	356,589	413,034	454,031	618,271	997,909	1,206,705	1,084,207	1,081,159	6,645,313

Sources:

[A] 2017 Ohio Neonatal Abstinence Syndrome Report, https://odh.ohio.gov/wps/wcm/connect/gov/73b5602a-eb7a-4967-92ba-113de136371d/2017%2BNAS%2BData%2BTable%2B10.25.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIKONJO00QO9DDDDM3000-73b5602a-eb7a-4967-92ba-113de136371d-muuj4xU

[B]

Notes:

Net patient revenue is defined as, "[t]he estimated net realizable amounts from patients, third-party payers, and others for services rendered." (AHA Hospital Statistics, 2009 Edition, p.208.) This measure is used to approximate hospital cost.

⁷ The AHA's measure of gross patient revenue is the sum of gross inpatient revenue and gross outpatient revenue. Both measures also reflect charges billed by the hospital. (AHA Hospital Statistics, 2009 Edition, pp. 206.) Net patient revenue is defined as, "[t]he estimated net realizable amounts from patients, third-party payers, and others for services rendered." (AHA Hospital Statistics, 2009 Edition, p. 208.)

⁸ Results using Professor Cutler's Approach 2 are found in Table E.4 below.

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Table E.4
Hospital Cost Estimates for NAS Attributable to Opioid Shipments
Approach 2

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
[1]	Opioid-related NAS Cases - Cuyahoga	16	20	26	35	47	61	79	101	104	107	131	725
[2]	Opioid-related NAS Cases - Summit	11	14	17	24	32	41	53	76	79	81	83	510
[3]	Average Charge for NAS in Ohio Hospitals ^[A]	39,561	59,033	59,580	72,158	64,911	59,847	57,813	61,469	68,666	61,241		
[4]	Average Charge for a Birth in Ohio Hospitals ^[A]	6,838	7,870	8,660	9,680	10,336	11,452	12,977	13,604	14,570	15,494		
[5]=[3]/[4]	Excess Charges for NAS Births	32,723	51,163	50,920	62,478	54,575	48,395	44,836	47,865	54,096	45,747	44,903	
[6]	Ohio Hospital Gross Patient Revenues (millions) ^[B]	64,339	69,105	77,003	85,584	93,353	99,617	108,810	117,265	125,847	134,927	1	
[7]	Ohio Hospital Net Patient Revenues (millions) ^[B]	25,333	26,372	28,423	30,514	31,793	32,381	35,605	37,124	39,137	41,324		
[8]=[7]/[6]	Net Revenue to Gross Charge Ratio	39.4%	38.2%	36.9%	35.7%	34.1%	32.5%	32.7%	31.7%	31.1%	30.6%	29.8%	
[9]=[5]*[8]	Excess Hospital Costs Due to NAS	12,885	19,525	18,795	22,276	18,587	15,731	14,671	15,153	16,823	14,011	13,397	
[10]=[1]*[9]	Total Cost of NAS Due to Shipments - Cuyahoga	207,564	389,339	482,161	775,046	869,337	956,065	1,153,313	1,523,314	1,751,577	1,492,644	1,753,364	11,353,726
[11]=[2]*[9]	Total Cost of NAS Due to Shipments - Summit	140,576	263,686	326,551	524,912	588,772	647,510	781,099	1,154,420	1,327,406	1,131,177	1,106,733	7,992,844

Sources:

[A] 2017 Ohio Neonatal Abstinence Syndrome Report, https://odh.ohio.gov/wps/wcm/connect/gov/73b5602a-eb7a-4967-92ba-113de136371d/2017%2BNAS%2BData%2BTable%2B10.25.2018.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_M1HGGIK0N0JO00QO9DDDDM3000-73b5602a-eb7a-4967-92ba-113de136371d-muuj4xU

[B] AHA Hospital Statistics, 2009, 2013, 2016, 2019 Editions, Ohio Table 6, p. 121.

Notes:

Charges in [3] and [4], "reflect charges billed by the hospital." (2017 Ohio Neonatal Abstinence Syndrome Report).

Gross patient revenues in [6] reflect revenue from services rendered to inpatients at full established rates, or "charges". (AHA Hospital Statistics, 2009 Edition, p.206.)

Net patient revenue is defined as, "[t]he estimated net realizable amounts from patients, third-party payers, and others for services rendered." (AHA Hospital Statistics, 2009 Edition, p.208.) This measure is used to approximate hospital cost.

The incremental costs I estimate are of the same magnitude as those estimated in an academic publication by Corr and Hollenbeak (2017).⁹ The authors use three different methods to compare NAS births to other births, and estimate incremental costs ranging from approximately \$9,000 to \$13,000.

⁹ T.E. Corr and C.S. Hollenbeak, "The Economic Burden of Neonatal Abstinence Syndrome in the United States," *Addiction*, 112, 2017, pp. 1590-1599.

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Appendix F
Technical Memo re Crime

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Appendix F Technical Memo re Crime

In Section I, this appendix summarizes the method I used to estimate the number of crimes that are due to prescription opioid shipments that I used in my Report. This method follows the analysis used in the Cutler Report to estimate the percent of costs incurred by crime-related Bellwether divisions that are due to prescription opioid shipments. In Section II, I describe my method for assigning a dollar value to the costs associated with crime.

I. Estimating Number of Crimes

Overview of Methodology

The estimation method used in the Cutler Report to calculate crime due to opioid shipments is executed using the following inputs:

$$\begin{aligned}
 \text{Crime due to shipments} = & \text{Crime} \times & (a) \\
 & \% \text{ of Crime that is Drug-Related} \times & (b) \\
 & \% \text{ of Drug-Related Crime that is Opioid-Related} \times & (c) \\
 & \% \text{ of Opioid-Related Harm that is Due to Shipments} & (d)
 \end{aligned}$$

Professor Cutler's analysis focuses on crime prevention efforts (and hence crimes) that are overseen by specific law enforcement divisions within the Bellwethers. Therefore, the data used to estimate the number of crime offenses (input (a) above) in these analyses are specific to the crime-related division in each Bellwether. For the analysis in my Report, I calculate the number of crimes in all law enforcement divisions for which data are available in each Bellwether county. Once the crime counts in each county have been calculated, the remaining inputs ((b) through (d)) can be used from the same sources and applied in the same manner as is done in the Cutler Report.¹

¹ Cutler Report, Appendix III.C.3 and Appendix III.1, Tables 1.4 and 1.5.

Crime Counts

For the purpose of measuring the total amount of criminal activity that occurred within Cuyahoga and Summit's geographic area, I calculate the total amount of criminal activity reported for all reporting Law Enforcement Agencies in the National Incident-Based Reporting System (NIBRS) data in which the 'primary county' listed is Cuyahoga/Summit. The NIBRS data is a standard source used to measure criminal offenses by criminal category for all law enforcement agencies (LEAs) that report into NIBRS (note that not every LEA reports into NIBRS currently). Due to underreporting of criminal activity in Cleveland in 2015, I use the average of 2014 and 2016 to approximate criminal activity in Cuyahoga in 2015.² The Cuyahoga Sheriff's office does not report to the NIBRS, so incidents investigated by that office are not included in the totals.

Estimates of Criminal Offenses Due to Prescription Opioids

The NIBRS data described above is used to generate estimates of criminal activity within the two counties. The remaining steps in the estimation follow the method described in the Cutler Report and use the same data inputs as described in that report.

- Input (b), the percent of these crime categories that can be attributable to drugs, is taken from US DOJ National Drug Intelligence Center.³ These estimates are applied to each year of the analysis.
- Input (c), the percent of drug-related crimes that are opioid-related, is estimated in two parts. This two-part method follows the literature, such as Florence et al (2016).⁴ The percent of drug crimes that are drug-related is estimated using information on the

² The NIBRS data for the Cleveland Police (which accounts for approximately 80% of Cuyahoga criminal activity) appear to contain errors as the numbers are significantly lower than those of 2014 or 2016.

³ See United States Department of Justice, National Drug Intelligence Center, "The Economic Impact of Illicit Drug Use on American Society," 2011, Table 1.7.

⁴ C. Florence, *et al.*, "The Economic Burden of Prescription Opioid Overdose, Abuse and Dependence in the United States, 2013," *Medical Care*, 54(10), 2016, pp. 901-906.

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percent of drug seizures in Ohio that contained opioids.⁵ The percent of drug-related crimes (e.g. burglaries that are motivated by drugs) that are opioid-related is estimated using the relative value of opioid use disorder (OUD) to substance use disorder (SUD) in Ohio as measured by NSDUH.⁶

- Input (d), the percent of opioid-related crimes that are due to shipments is approximated using mortality regressions using two different approaches. Approach 1 and Approach 2 are described in more detail in the Cutler Report.

Combining the above inputs yields two estimates (one using Approach 1 and one using Approach 2) of the number of crimes occurring in each of the counties that are due to prescription opioid shipments. Tables F.1a and F.1b present these estimates for Cuyahoga and Summit counties, respectively, for Approach 1. Tables F.2a and F.2b do so for Approach 2. The last lines in Tables F.1a and F.1b appear in Tables 9a and 9b in my Report.

⁵ Ohio forensic laboratories reporting to the National Forensic Laboratory Information System (NFLIS), U.S. Drug Enforcement Administration, Diversion Control Division, 2007-2017, Table 2.

⁶ Note that state-specific estimates are not available for 2014 and NSDUH's definition of OUD changed in 2015. As a result, the Cutler Report holds this value constant after 2013.

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Table F.1a
Estimates of Crimes Due to Shipments
Cuyahoga County
Approach 1

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	11	11	13	14	15	15	18	20	20	28	36	199
All Other Offenses	7	6	8	9	10	10	12	14	14	17	19	126
Arson	1	1	1	1	1	1	1	1	1	1	2	12
Burglary	460	449	582	595	685	747	873	839	779	812	813	7,633
Curfew/Loitering/Vagrancy												
Disorderly Conduct												
Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
Drug Crimes	584	534	628	747	943	931	1,164	1,087	1,291	1,538	1,637	11,084
Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
Forcible Rape	4	3	4	4	4	4	6	6	8	9	10	63
Forgery and Fraud	128	122	144	144	143	154	230	214	246	258	260	2,045
Gambling Offenses												
Human Trafficking												
Larceny-theft	872	829	1,041	1,050	1,112	1,239	1,557	1,559	1,666	1,777	1,826	14,527
Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
Motor Vehicle Theft	218	231	235	177	168	211	246	294	298	348	389	2,815
Murder	0	0	0	1	1	1	1	1	1	1	2	8
Other Assaults	100	99	123	134	147	139	181	203	217	239	254	1,836
Prostitution	20	19	27	30	31	31	38	37	33	23	11	301
Robbery	166	159	199	191	183	188	246	293	275	283	279	2,462
Sex Offenses	1	1	1	1	1	1	1	1	1	1	1	10
Stolen Property	25	27	27	9	8	9	12	10	14	17	19	178
Vandalism	40	39	48	49	47	48	61	62	69	89	107	658
Weapons	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,636	2,531	3,082	3,155	3,498	3,728	4,648	4,641	4,932	5,441	5,665	43,957

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Table F.1b
Estimates of Crimes Due to Shipments
Summit County
Approach 1

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	2	3	6	6	6	6	9	9	9	8	8	74
All Other Offenses	1	2	2	2	2	2	3	3	3	4	4	27
Arson	0	0	0	0	0	0	0	0	0	0	0	3
Burglary	155	157	236	238	291	308	314	341	337	344	336	3,057
Curfew/Loitering/Vagrancy												
Disorderly Conduct												
Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
Drug Crimes	285	251	353	435	547	556	693	891	1,123	1,383	1,593	8,110
Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
Embezzlement	2	0	0	0	0	0	0	0	0	0	0	3
Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
Forcible Rape	1	1	2	2	2	2	3	3	3	4	5	27
Forgery and Fraud	45	53	77	85	80	83	99	128	141	194	187	1,172
Gambling Offenses												
Human Trafficking												
Larceny-theft	292	283	400	397	447	469	582	722	755	821	858	6,026
Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
Motor Vehicle Theft	45	40	44	45	39	45	51	50	51	63	72	544
Murder	0	0	0	0	0	0	0	0	0	0	0	2
Other Assaults	41	40	54	53	57	57	72	80	85	98	106	743
Prostitution	8	17	24	15	14	8	7	4	3	3	6	110
Robbery	27	28	42	38	34	43	44	47	42	44	45	435
Sex Offenses	0	0	0	0	0	0	0	1	1	1	1	5
Stolen Property	6	4	6	6	6	8	9	11	10	13	16	95
Vandalism	21	20	25	25	27	26	30	32	32	38	40	315
Weapons	2	2	2	2	2	3	3	4	3	4	5	32
Total	934	903	1,275	1,350	1,556	1,616	1,918	2,324	2,600	3,021	3,281	20,779

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Table F.2a
Estimates of Crimes Due to Shipments
Cuyahoga County
Approach 2

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	19	18	21	21	21	21	23	23	22	29	36	254
All Other Offenses	11	10	14	13	14	14	16	16	16	18	19	161
Arson	2	2	2	1	1	1	1	1	1	1	2	16
Burglary	782	763	971	876	976	1,066	1,103	971	857	847	833	10,043
Curfew/Loitering/Vagrancy												
Disorderly Conduct												
Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
Drug Crimes	993	908	1,047	1,100	1,345	1,327	1,471	1,257	1,420	1,605	1,676	14,150
Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
Embezzlement	0	0	0	0	0	0	0	0	0	0	0	0
Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
Forcible Rape	6	6	7	7	6	6	7	8	9	9	10	80
Forgery and Fraud	218	208	241	212	204	220	291	248	271	269	266	2,647
Gambling Offenses												
Human Trafficking												
Larceny-theft	1,484	1,410	1,737	1,546	1,586	1,766	1,966	1,803	1,832	1,854	1,869	18,854
Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
Motor Vehicle Theft	371	393	392	260	239	301	311	340	328	363	399	3,697
Murder	1	1	1	1	1	1	1	1	1	1	2	10
Other Assaults	170	168	205	197	210	199	229	235	238	249	260	2,360
Prostitution	34	33	45	45	44	44	48	42	37	24	12	407
Robbery	282	271	332	281	261	269	311	339	302	295	286	3,229
Sex Offenses	1	1	1	1	1	1	1	1	1	1	1	13
Stolen Property	43	46	46	13	11	12	15	12	16	18	20	251
Vandalism	68	67	81	72	66	68	77	71	76	93	110	848
Weapons	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,484	4,304	5,142	4,645	4,986	5,316	5,872	5,369	5,426	5,677	5,799	57,019

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Table F.2b
Estimates of Crimes Due to Shipments
Summit County
Approach 2

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	4	5	10	9	9	9	11	11	10	9	9	95
All Other Offenses	2	3	3	3	3	3	3	4	3	4	4	35
Arson	0	0	0	0	0	0	0	0	0	0	1	4
Burglary	263	267	394	351	415	439	396	394	371	358	344	3,994
Curfew/Loitering/Vagrancy												
Disorderly Conduct												
Driving Under the Influence	0	0	0	0	0	0	0	0	0	0	0	0
Drug Crimes	485	428	589	640	779	793	875	1,031	1,235	1,442	1,630	9,929
Drunkenness	0	0	0	0	0	0	0	0	0	0	0	0
Embezzlement	4	1	0	0	0	0	0	0	0	0	0	5
Family and Children	0	0	0	0	0	0	0	0	0	0	0	0
Forcible Rape	2	3	3	3	3	3	3	3	4	4	5	35
Forgery and Fraud	76	89	129	125	115	118	126	148	155	202	192	1,474
Gambling Offenses												
Human Trafficking												
Larceny-theft	497	482	668	584	637	668	735	835	831	857	878	7,672
Liquor Laws	0	0	0	0	0	0	0	0	0	0	0	0
Motor Vehicle Theft	76	68	74	66	56	64	64	57	56	66	73	720
Murder	0	0	0	0	0	0	0	0	0	0	0	3
Other Assaults	70	69	90	77	82	81	90	92	94	103	108	956
Prostitution	14	29	41	23	20	12	9	4	3	3	6	163
Robbery	46	48	70	57	49	61	55	55	47	45	46	579
Sex Offenses	0	0	0	0	1	1	1	1	1	1	1	6
Stolen Property	10	8	10	9	9	11	11	12	11	14	16	121
Vandalism	35	34	41	36	39	37	38	37	36	39	41	412
Weapons	3	3	4	3	3	4	4	4	4	4	6	41
Total	1,590	1,536	2,127	1,987	2,219	2,304	2,423	2,689	2,860	3,152	3,359	26,245

II. Valuation of Criminal Offenses Due to Shipments of Prescription Opioids

The main source of monetary estimates is McCollister *et al.*⁷ The authors estimate the cost of crime by offense category using two methods: cost-of-illness and jury compensation. The cost-of-illness approach identifies a comprehensive list of costs imposed by crime on society, including property loss, medical costs, lost productivity, crime prevention expenses, pain and suffering. These costs are then attributed to different crime categories (theft, arson, etc.) to estimate a “per-offense” unit cost by type of criminal activity. The jury-compensation approach is an estimation method for the intangible costs of crime, such as pain and suffering, derived from data on jury awards received by crime victims.⁸ These two methodologies allow for the disaggregation of the unit cost of a given crime into direct, indirect and intangible costs and are widely used in the crime cost literature.⁹

I then match the offense categories in our data on criminal activity due to shipments to the per-offense cost estimates available in the literature.¹⁰ I rely on other research papers to value crimes not covered in McCollister *et al.*¹¹ Cost estimates per offense are not available for all crimes (such as disorderly conduct). In these cases, no costs are assigned.

⁷ K.E. McCollister, M.T. French and H. Fang, “The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation,” *Drug and Alcohol Dependence*, 108(1), 2010, pp. 98-109

⁸ M.A. Cohen, “Pain, Suffering, and Jury Awards: A Study of the Cost of Crime to Victims,” *Law & Society Review*, 22(3), 1988, 537.

⁹ Examples of these approaches are: D.A. Anderson, “The Cost of Crime,” *Foundations and Trends® in Microeconomics*, 7(3), 2012, pp. 209-265. and T.R. Miller, M.A. Cohen and D. Hendrie, “Non-Economic Damages Due to Physical and Sexual Assault: Estimates from Civil Jury Awards,” *Forensic Science and Criminology*, 2(1), 2017, pp. 1-10.

¹⁰ Some of these categories do not match 1-1, or there are difficulties in finding per-offense costs for some crimes. I specify the sources for each crime category in the notes for Table F.3. In particular, I do not have the adjusted risk-of-homicide crime costs for crimes not available in McCollister *et al.*, *op. cit.* Other assumptions include the use of the sexual assault per-offense cost to crimes in the data categorized as forcible rape.

¹¹ I supplement my unit-cost crimes using the estimates available in T. Miller and S. Bhattacharya, “Incidence and Cost of Carbon Monoxide Poisoning for All Ages, Pool and Spa Submersions for Ages 0– 14, and Lead Poisoning for Ages 0-4,” 2013, Table 20, available at <https://www.cpsc.gov/Global/Research-and-statistics/Injury-statistics/Carbon-monoxide-poisoning/Incidence-and-Cost-of-Carbon-Monoxide-Poisoning-Pool-and-Spa-Submersion-and-Lead-Poisoning.pdf>.

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Finally, I multiply the counts in each crime category by the corresponding per-offense cost estimate, which yields the total crime costs broken into direct, indirect and intangible costs.

Table F.3 identifies the category of offense and the costs I use to value direct, implicit and intangible costs. The table identifies the sources for those numbers. Total costs appear in Tables F4a and F4b for Approach 1 and F5a and F5b for Approach 2. The sum of these costs by year for each of the counties (*i.e.*, the last lines of Tables F.4a and F.4b), appear in Tables 9a and 9b in my Report.

Table F.3
Summary of Costs by Offense

Category of Offense	Direct Cost/Offense		Implicit Cost/Offense		Intangible Costs/Offense		Total All Costs	Note
	Crime Victim Cost	Crime Career Cost	Pain and Suffering	Adjusted Risk of Homicide				
Aggravated Assault	\$8,700	\$2,126	\$13,435	\$81,588	\$105,849	[1] Aggravated Assault [13] All Other Nontraffic Offenses		
All Other Offenses	\$70	\$92	N/A	N/A	\$162			
Arson	\$11,452	\$584	\$0	\$5,133	\$17,169			
Burglary	\$1,362	\$681	\$0	\$321	\$2,364	[2] Arson [3] Burglary		
Curfew/Loitering/Vagrancy					\$0	[14] Drug Possession/Sales		
Disorderly Conduct					\$0			
Driving Under the Influence					\$0			
Drug Crimes	\$4,490	\$1,118	\$0	N/A	\$5,608	[4] Drug Possession/Sales		
Drunkenness					\$0			
Embezzlement	\$0	\$660	N/A	N/A	\$660			
Family and Children					\$0	[4] Embezzlement		
Forcible Rape	\$5,556	\$9,212	\$198,212	\$1,430	\$214,410			
Forgery and Fraud	\$0	\$660	N/A	N/A	\$660			
Gambling Offenses					\$0	[5] Sexual Assault [6] Forgery/counterfeiting and Fraud		
Human Trafficking					\$0			
Larceny-theft	\$480	\$163	\$0	\$10	\$653			
Liquor Laws					\$0	[7] Larceny		
Motor Vehicle Theft	\$6,114	\$553	\$0	\$262	\$6,929			
Murder	\$737,517	\$148,555	\$8,442,000	\$0	\$9,328,072			
Other Assaults	\$3,425	\$1,878	\$13,069	N/A	\$18,372	[8] Motor Vehicle Theft [9] Murder		
Prostitution	\$70	\$80	\$0	N/A	\$150			
Robbery	\$3,299	\$4,272	\$4,976	\$17,599	\$30,146			
Sex Offenses	\$5,686	\$9,517	\$89,784	N/A	\$104,987	[10] Robbery [17] Other Sexual Assault		
Stolen Property	\$0	\$1,132	N/A	N/A	\$1,132			
Vandalism	\$0	\$701	N/A	N/A	\$701			
Weapons	\$70	\$799	\$0	N/A	\$869	[11] Stolen Property [12] Vandalism [18] Weapons Carrying		

Notes: [1] - [12] are in 2008 dollars. Costs are from McCollister *et al.* (2010) Tables 3 & 4.

[13] - [18] are in 2010 dollars. Costs are from Miller and Bhattacharya (2013) Table 2. I treat medical costs, lost wages, property damage and public services as Direct Costs. Implicit Costs are Perpetrator Work Loss. Intangible costs, under Pain and Suffering come from Mental Health Costs and Quality of Life costs.

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Table F.4a
Valuation of Crimes Due to Shipments
Cuyahoga County
Approach 1

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	\$1,175,326	\$1,126,006	\$1,323,285	\$1,477,418	\$1,534,927	\$1,573,591	\$1,939,814	\$2,100,607	\$2,123,465	\$2,961,293	\$3,773,138	\$21,108,869
All Other Offenses	\$1,074	\$997	\$1,376	\$1,453	\$1,572	\$1,556	\$2,001	\$2,215	\$2,349	\$2,738	\$3,057	\$20,386
Arson	\$15,377	\$16,289	\$20,889	\$16,406	\$16,262	\$14,513	\$17,880	\$20,446	\$22,070	\$24,382	\$25,926	\$210,441
Burglary	\$1,086,617	\$1,060,288	\$1,375,926	\$1,406,024	\$1,618,606	\$1,766,371	\$2,063,788	\$1,984,490	\$1,841,356	\$1,918,526	\$1,922,588	\$18,044,581
Curfew/Loitering/Vagrancy												\$0
Disorderly Conduct												\$0
Driving Under the Influence												\$0
Drug Crimes	\$3,275,095	\$2,993,569	\$3,519,067	\$4,191,475	\$5,291,023	\$5,219,149	\$6,530,401	\$6,093,566	\$7,237,527	\$8,627,237	\$9,182,061	\$62,160,169
Drunkenness												\$0
Embezzlement												\$0
Family and Children												\$0
Forcible Rape	\$754,472	\$698,671	\$956,457	\$948,837	\$882,547	\$881,934	\$1,209,379	\$1,391,968	\$1,709,603	\$1,929,779	\$2,093,647	\$13,457,294
Forgery and Fraud	\$84,439	\$80,845	\$95,334	\$94,939	\$94,510	\$101,850	\$152,117	\$141,396	\$162,435	\$170,119	\$171,423	\$1,349,407
Gambling Offenses												\$0
Human Trafficking												\$0
Larceny-theft	\$569,684	\$541,411	\$679,722	\$685,684	\$726,421	\$808,839	\$1,016,421	\$1,017,851	\$1,087,691	\$1,160,436	\$1,192,111	\$9,486,271
Liquor Laws												\$0
Motor Vehicle Theft	\$1,511,073	\$1,599,281	\$1,628,688	\$1,225,769	\$1,161,918	\$1,461,724	\$1,705,025	\$2,039,328	\$2,063,139	\$2,411,550	\$2,698,449	\$19,505,942
Murder	\$3,214,554	\$4,280,851	\$3,595,515	\$4,916,359	\$5,034,640	\$5,037,306	\$6,839,391	\$5,552,396	\$6,695,626	\$11,126,550	\$15,614,896	\$71,908,083
Other Assaults	\$1,834,443	\$1,814,502	\$2,252,667	\$2,464,496	\$2,705,109	\$2,561,601	\$3,328,275	\$3,725,435	\$3,978,454	\$4,392,211	\$4,667,251	\$33,724,443
Prostitution	\$2,980	\$2,879	\$4,043	\$4,547	\$4,637	\$4,617	\$5,732	\$5,502	\$4,994	\$3,514	\$1,705	\$45,149
Robbery	\$4,998,756	\$4,806,007	\$5,994,559	\$5,755,648	\$5,515,863	\$5,680,642	\$7,417,422	\$8,834,820	\$8,284,976	\$8,522,744	\$8,423,045	\$74,234,482
Sex Offenses	\$65,853	\$65,306	\$74,138	\$83,215	\$92,043	\$76,663	\$111,580	\$114,038	\$110,409	\$119,431	\$124,411	\$1,037,086
Stolen Property	\$28,753	\$30,630	\$30,923	\$9,898	\$8,871	\$9,817	\$13,436	\$11,818	\$16,091	\$19,095	\$21,643	\$200,975
Vandalism	\$27,919	\$27,553	\$33,933	\$34,153	\$32,687	\$33,580	\$42,498	\$43,273	\$48,204	\$62,202	\$75,219	\$461,220
Weapons												\$0
Total	\$18,646,413	\$19,145,083	\$21,586,522	\$23,316,320	\$24,721,636	\$25,233,754	\$32,395,157	\$33,079,149	\$35,388,388	\$43,451,808	\$49,990,569	\$326,954,800

Table F.4b
Valuation of Crimes Due to Shipments
Summit County
Approach 1

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	\$240,702	\$329,957	\$610,629	\$677,347	\$650,436	\$674,396	\$950,577	\$972,245	\$966,342	\$873,995	\$889,438	\$7,836,064
All Other Offenses	\$234	\$246	\$318	\$311	\$319	\$352	\$422	\$498	\$482	\$611	\$582	\$4,374
Arson	\$2,378	\$3,844	\$4,781	\$4,450	\$5,001	\$4,766	\$6,378	\$6,268	\$5,368	\$7,150	\$8,469	\$58,853
Burglary	\$365,921	\$371,530	\$558,645	\$563,387	\$687,828	\$727,742	\$741,633	\$805,454	\$797,545	\$812,162	\$794,410	\$7,226,257
Curfew/Loitering/Vagrancy												\$0
Disorderly Conduct												\$0
Driving Under the Influence												\$0
Drug Crimes	\$1,597,949	\$1,410,362	\$1,981,190	\$2,438,916	\$3,066,541	\$3,120,133	\$3,884,068	\$4,997,350	\$6,297,010	\$7,753,293	\$8,932,315	\$45,479,127
Drunkenness												\$0
Embezzlement	\$1,566	\$244	\$10	\$20	\$21	\$0	\$0	\$0	\$0	\$19	\$0	\$1,879
Family and Children												\$0
Forcible Rape	\$286,871	\$321,448	\$386,487	\$434,383	\$429,405	\$412,481	\$561,291	\$568,414	\$717,611	\$751,418	\$1,021,195	\$5,891,004
Forgery and Fraud	\$29,463	\$34,689	\$50,947	\$55,933	\$53,118	\$54,551	\$65,585	\$84,410	\$93,260	\$127,954	\$123,633	\$773,543
Gambling Offenses												\$0
Human Trafficking												\$0
Larceny-theft	\$190,960	\$185,046	\$261,349	\$259,100	\$291,844	\$306,060	\$379,747	\$471,347	\$493,107	\$536,181	\$560,052	\$3,934,791
Liquor Laws												\$0
Motor Vehicle Theft	\$311,441	\$275,617	\$306,767	\$311,503	\$270,629	\$309,180	\$350,270	\$343,366	\$354,231	\$439,190	\$495,611	\$3,767,805
Murder	\$1,232,979	\$991,355	\$1,078,654	\$1,229,090	\$1,589,886	\$1,888,990	\$2,398,228	\$2,181,298	\$2,915,837	\$3,844,776	\$3,873,463	\$23,224,557
Other Assaults	\$754,854	\$741,838	\$993,233	\$966,054	\$1,051,963	\$1,043,990	\$1,315,698	\$1,464,317	\$1,561,798	\$1,808,768	\$1,943,406	\$13,645,918
Prostitution	\$1,222	\$2,567	\$3,653	\$2,312	\$2,089	\$1,265	\$1,083	\$542	\$409	\$441	\$865	\$16,446
Robbery	\$820,979	\$853,280	\$1,258,712	\$1,157,711	\$1,039,968	\$1,292,448	\$1,318,749	\$1,423,803	\$1,280,071	\$1,312,936	\$1,355,229	\$13,113,887
Sex Offenses	\$21,193	\$29,161	\$30,307	\$33,754	\$46,832	\$41,090	\$52,409	\$60,928	\$52,562	\$53,538	\$57,927	\$479,699
Stolen Property	\$6,611	\$5,065	\$7,075	\$6,978	\$6,922	\$8,894	\$9,783	\$12,118	\$11,528	\$14,723	\$17,579	\$107,275
Vandalism	\$14,440	\$13,873	\$17,320	\$17,199	\$18,975	\$18,013	\$20,984	\$22,569	\$22,668	\$26,388	\$28,133	\$220,561
Weapons	\$1,620	\$1,467	\$1,997	\$1,884	\$1,928	\$2,189	\$2,942	\$3,053	\$2,846	\$3,325	\$4,768	\$28,017
Total	\$5,881,382	\$5,571,590	\$7,552,072	\$8,160,331	\$9,213,704	\$9,906,539	\$12,059,844	\$13,417,978	\$15,572,676	\$18,366,868	\$20,107,073	\$125,810,057

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Table F.5a
Valuation of Crimes Due to Shipments
Cuyahoga County
Approach 2

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	\$1,999,321	\$1,915,069	\$2,207,744	\$2,174,812	\$2,188,008	\$2,244,157	\$2,450,687	\$2,430,066	\$2,335,864	\$3,089,583	\$3,862,392	\$26,897,702
All Other Offenses	\$1,827	\$1,695	\$2,295	\$2,139	\$2,241	\$2,219	\$2,527	\$2,562	\$2,584	\$2,857	\$3,129	\$26,075
Arson	\$26,158	\$27,703	\$34,851	\$24,151	\$23,182	\$20,697	\$22,589	\$23,652	\$24,278	\$25,439	\$26,540	\$279,239
Burglary	\$1,848,420	\$1,803,299	\$2,295,570	\$2,069,717	\$2,307,291	\$2,519,087	\$2,607,311	\$2,295,737	\$2,025,538	\$2,001,641	\$1,968,067	\$23,741,679
Curfew/Loitering/Vagrancy												\$0
Disorderly Conduct												\$0
Driving Under the Influence												\$0
Drug Crimes	\$5,571,192	\$5,091,351	\$5,871,148	\$6,169,998	\$7,542,249	\$7,443,222	\$8,250,258	\$7,049,280	\$7,961,461	\$9,000,990	\$9,399,263	\$79,350,412
Drunkenness												\$0
Embezzlement												\$0
Family and Children												\$0
Forcible Rape	\$1,283,416	\$1,188,275	\$1,595,736	\$1,396,721	\$1,258,053	\$1,257,759	\$1,527,883	\$1,610,284	\$1,880,606	\$2,013,382	\$2,143,172	\$17,155,286
Forgery and Fraud	\$143,638	\$137,498	\$159,053	\$139,754	\$134,722	\$145,252	\$192,179	\$163,572	\$178,683	\$177,489	\$175,478	\$1,747,318
Gambling Offenses												\$0
Human Trafficking												\$0
Larceny-theft	\$969,077	\$920,812	\$1,134,037	\$1,009,350	\$1,035,499	\$1,153,516	\$1,284,107	\$1,177,491	\$1,196,487	\$1,210,709	\$1,220,311	\$12,311,395
Liquor Laws												\$0
Motor Vehicle Theft	\$2,570,453	\$2,719,998	\$2,717,273	\$1,804,375	\$1,656,291	\$2,084,618	\$2,154,063	\$2,359,176	\$2,269,504	\$2,516,023	\$2,762,281	\$25,614,056
Murder	\$5,468,207	\$7,280,714	\$5,998,692	\$7,237,053	\$7,176,780	\$7,183,889	\$8,640,625	\$6,423,233	\$7,365,356	\$11,608,578	\$15,984,268	\$90,367,394
Other Assaults	\$3,120,531	\$3,086,038	\$3,758,310	\$3,627,824	\$3,856,079	\$3,653,194	\$4,204,815	\$4,309,732	\$4,376,399	\$4,582,492	\$4,777,655	\$43,353,069
Prostitution	\$5,070	\$4,897	\$6,746	\$6,693	\$6,609	\$6,585	\$7,241	\$6,365	\$5,493	\$3,666	\$1,745	\$61,110
Robbery	\$8,503,274	\$8,173,881	\$10,001,214	\$8,472,516	\$7,862,754	\$8,101,375	\$9,370,887	\$10,220,472	\$9,113,681	\$8,891,969	\$8,622,293	\$97,334,315
Sex Offenses	\$112,022	\$111,069	\$123,690	\$122,495	\$131,206	\$109,332	\$140,966	\$131,924	\$121,453	\$124,605	\$127,354	\$1,356,114
Stolen Property	\$48,910	\$52,094	\$51,591	\$14,571	\$12,645	\$14,001	\$16,974	\$13,672	\$17,700	\$19,923	\$22,155	\$284,236
Vandalism	\$47,492	\$46,860	\$56,613	\$50,275	\$46,595	\$47,889	\$53,690	\$50,060	\$53,025	\$64,896	\$76,998	\$594,395
Weapons												\$0
Total	\$31,719,006	\$32,561,254	\$36,014,562	\$34,322,442	\$35,240,206	\$35,986,794	\$40,926,801	\$38,267,280	\$38,928,112	\$45,334,242	\$51,173,100	\$420,473,796

Table F.5b
Valuation of Crimes Due to Shipments
Summit County
Approach 2

Category of Offense	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Aggravated Assault	\$409,453	\$561,178	\$1,018,762	\$997,078	\$927,184	\$961,782	\$1,200,923	\$1,124,731	\$1,063,001	\$911,859	\$910,478	\$10,086,428
All Other Offenses	\$397	\$418	\$530	\$457	\$454	\$501	\$533	\$576	\$531	\$637	\$596	\$5,632
Arson	\$4,045	\$6,538	\$7,977	\$6,551	\$7,128	\$6,797	\$8,058	\$7,251	\$5,905	\$7,460	\$8,669	\$76,379
Burglary	\$622,461	\$631,884	\$932,033	\$829,325	\$980,485	\$1,037,860	\$936,951	\$931,781	\$877,319	\$847,347	\$813,202	\$9,440,648
Curfew/Loitering/Vagrancy												\$0
Disorderly Conduct												\$0
Driving Under the Influence												\$0
Drug Crimes	\$2,718,236	\$2,398,692	\$3,305,382	\$3,590,170	\$4,371,294	\$4,449,738	\$4,906,983	\$5,781,134	\$6,926,869	\$8,089,183	\$9,143,609	\$55,681,290
Drunkenness												\$0
Embezzlement	\$2,663	\$415	\$16	\$29	\$30	\$0	\$0	\$0	\$0	\$19	\$0	\$3,173
Family and Children												\$0
Forcible Rape	\$487,991	\$546,706	\$644,807	\$639,427	\$612,109	\$588,254	\$709,113	\$657,564	\$789,390	\$783,972	\$1,045,351	\$7,504,685
Forgery and Fraud	\$50,118	\$58,998	\$84,999	\$82,335	\$75,719	\$77,797	\$82,857	\$97,649	\$102,589	\$133,497	\$126,558	\$973,117
Gambling Offenses												\$0
Human Trafficking												\$0
Larceny-theft	\$324,837	\$314,720	\$436,029	\$381,404	\$416,017	\$436,484	\$479,757	\$545,274	\$542,429	\$559,409	\$573,300	\$5,009,661
Liquor Laws												\$0
Motor Vehicle Theft	\$529,785	\$468,760	\$511,804	\$458,543	\$385,777	\$440,933	\$442,517	\$397,219	\$389,663	\$458,217	\$507,335	\$4,990,553
Murder	\$2,097,394	\$1,686,060	\$1,799,608	\$1,809,263	\$2,266,352	\$2,693,958	\$3,029,829	\$2,523,413	\$3,207,494	\$4,011,341	\$3,965,090	\$29,089,802
Other Assaults	\$1,284,065	\$1,261,691	\$1,657,092	\$1,422,066	\$1,499,552	\$1,488,873	\$1,662,203	\$1,693,980	\$1,718,016	\$1,887,128	\$1,989,377	\$17,564,043
Prostitution	\$2,078	\$4,365	\$6,094	\$3,404	\$2,977	\$1,804	\$1,368	\$627	\$449	\$460	\$885	\$24,512
Robbery	\$1,396,550	\$1,451,228	\$2,100,012	\$1,704,191	\$1,482,454	\$1,843,208	\$1,666,057	\$1,647,112	\$1,408,110	\$1,369,816	\$1,387,287	\$17,456,025
Sex Offenses	\$36,051	\$49,596	\$50,563	\$49,687	\$66,758	\$58,600	\$66,211	\$70,484	\$57,819	\$55,857	\$59,297	\$620,923
Stolen Property	\$11,246	\$8,615	\$11,804	\$10,271	\$9,867	\$12,684	\$12,360	\$14,018	\$12,682	\$15,360	\$17,995	\$136,901
Vandalism	\$24,563	\$23,595	\$28,896	\$25,318	\$27,049	\$25,688	\$26,510	\$26,108	\$24,935	\$27,531	\$28,798	\$288,992
Weapons	\$2,755	\$2,495	\$3,332	\$2,773	\$2,748	\$3,122	\$3,716	\$3,532	\$3,131	\$3,469	\$4,881	\$35,952
Total	\$10,004,690	\$9,475,955	\$12,599,740	\$12,012,293	\$13,133,954	\$14,128,083	\$15,235,946	\$15,522,453	\$17,130,332	\$19,162,564	\$20,582,707	\$158,988,717

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Appendix G
Technical Memo re Child Maltreatment

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Appendix G

Technical Memo re Child Maltreatment

In Section I, I describe the source for the calculation of maltreated children over time in the Bellwether counties. In Section II, I discuss the method for valuing the social costs of this maltreatment imposed on the children and wider society.

I. Maltreatment Data for Cuyahoga and Summit Counties.

The number of children maltreated due to opioid shipments is obtained in two steps. First, Dr. Nancy Young's Report filed in this matter identifies a unique count of victims of substantiated maltreatment in Cuyahoga and Summit counties from 2002 through 2016 in her Graphics 12 and 13.

Tables G.1a and G.1b is a replication of the numbers Dr. Young reports for 2006-2016. These numbers appear in my Tables 10a and 10b in my Report.

Table G.1a
Number of Substantiated Maltreatment Child Victims, 2006-2016
Cuyahoga County

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Cases of Maltreatment	2,043	1,924	2,073	1,452	1,738	2,092	2,156	2,502	2,281	2,316	2,513	23,090

Source: Young Report, Graphic 12.

Table G.1b
Number of Substantiated Maltreatment Child Victims, 2006-2016
Summit County

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Cases of Maltreatment	1,319	1,117	901	944	715	643	674	601	579	757	886	9,136

Source: Young Report, Graphic 13.

Secondly, I apply Professor Cutler's share of harms due to opioid shipments to obtain the number of children maltreated due to opioid shipments. The shares of harms are from the Cutler Report, Appendix III.I, Tables I.6 and I.7. Note that these shares also adjust for the share of maltreatment due to opioids. These numbers are reported below in Tables G.2a and G.2b

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for Approach 1 and Tables G.3a and G.3b for Approach 2. The Approach 1 numbers also appear in my Tables 10a and 10b in my Report.

II. Calculation of Costs of Child Maltreatment in the Bellwethers

Fang *et al.*, (2012) estimates an average lifetime cost per victim of nonfatal child maltreatment of \$210,012 in 2010 dollars.¹ This lifetime cost includes costs of childhood health care, adult medical costs, productivity losses, child welfare costs, criminal justice costs and special education costs. The method for counting maltreated children outlined above is consistent with Fang *et al.*'s methodology in that it uses the same source for the incidence of maltreatment, the US Department of Health and Human Services' (HHS) Annual Report on Child Maltreatment – counts of victims of maltreatment.²

As this suggests, the Fang *et al.* cost estimate includes elements that are already covered in estimates of the costs faced by Bellwether counties from the McGuire Damages Report. In order to avoid double counting, I exclude the following cost categories from my analysis here (*i.e.*, from the Fang *et al.* estimates):

- Child Welfare Costs – the cost report measures expenditures by the Bellwether counties' divisions of children and family services and
- Criminal Justice Costs – the cost report measures expenditures by the Bellwether counties' juvenile courts, sheriff's offices and county jails

Excluding these costs is conservative, since some of the child welfare and criminal justice costs will not fall on the Bellwether county governments. Furthermore, costs of children maltreated today will fall on Bellwether jurisdictions many years in the future.

I estimate the social costs associated with child maltreatment in two categories: productivity and special education.

¹ X. Fang, *et al.*, "The Economic Burden of Child Maltreatment in the United States and Implications for Prevention," *Child Abuse & Neglect*, 36, 2012, pp. 156-165.

² See Children's Bureau, Office of the Administration for Children & Families, U.S. Department of Health and Human Services, "Child Maltreatment," January 28, 2019, available at <https://www.acf.hhs.gov/cb/research-data-technology/statistics-research/child-maltreatment>.

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Productivity Losses

Childhood maltreatment has adverse effects on economic outcomes in adulthood. Currie & Widom (2010)³ tracks matched cohorts from an earlier study of childhood maltreatment into adulthood.⁴ The authors find that adults who experienced validated and substantiated maltreatment as children earn approximately \$6,500 less annually (2003 dollars) and are 14 percentage points less likely to be employed at middle age (mean age 41).

To keep the calculations simple, I sum the total earnings lost per maltreated child with no discounting and no adjustments for inflation or productivity growth. If on average a person works 44 years (from age 21 through 64) and loses \$6,500 per year, the total lost earnings over a lifetime is \$286,000.

Tables G.2a and G.2b combine data on counts with estimates of lost earnings to estimate total lost earnings due to shipments under Approach 1. Tables G.3a and G.3b do the same for Approach 2. The total value of productivity losses from maltreatment cases due to opioid shipments is \$693 million for Approach 1 and \$840 million for Approach 2.

In addition to earnings differences, maltreated children are less likely to own assets (*e.g.*, stock, a vehicle, a home) in adulthood than children who did not experience maltreatment.⁵ I do not attribute dollar values to these adverse events or include these differences in the cost of maltreatment.

Special Education

A study by Jonson-Reid *et al.* (2004)⁶ finds that maltreated children are 10.5 percentage points more likely to need special education services (*i.e.*, receive services for an educational

³ J. Currie and C.S. Widom, "Long-Term Consequences of Child Abuse and Neglect on Adult Economic Well-Being," *Child Maltreatment*, 15(2), 2010, pp. 111-120.

⁴ See C.S. Widom, "The Cycle of Violence," *Science*, April 14, 1989, pp. 160-166.

⁵ Currie & Widom, *op cit.*

⁶ M. Jonson-Reid, *et al.*, "A Prospective Analysis of the Relationship Between Reported Child Maltreatment and Special Education Eligibility Among Poor Children," *Child Maltreatment*, 9(4), November 2004, pp. 381-394.

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disability) than children who are impoverished but not maltreated (24.2% vs. 13.7%). This effect remains consistent after controlling for potential confounders (hazard ratio = 1.9).

Research shows that students needing special education services cost \$9,298 more annually than regular students.⁷ Students remain in special education on average approximately two years,⁸ leading to a total incremental average cost per maltreated child of \$1,952.58 ($.105 * \$9,298 * 2$). This value is used for all years 2006-2016. The total value of the increase in special education costs from maltreatment cases due to opioid shipments is \$4.7 million for Approach 1 and \$5.7 million for Approach 2. See Tables G.2a and G.2b for Approach 1 and Tables G.3a and G.3b for Approach 2.

Note on Additional Costs

The categories above are not an exhaustive list of the social costs of childhood maltreatment. As an example of the effects of maltreatment on educational and developmental outcomes, children who are maltreated complete fewer years of schooling,⁹ have lower IQ scores in young

⁷ Chambers *et al.* report that “Per pupil education expenditures for students who receive special education services (excluding homebound students) are 1.91 times greater than expenditures for students who receive no special education services.” The National Center for Education Statistics, Digest of Education Statistics report that in 2014-2015, cost per pupil averaged \$11,445 with 13.2% of children receiving school-based special education services in 2015-16. Using these inputs, I determine that the average cost over all students is \$10,218 and that the cost for special education students is \$19,516 ($\$10,218 * 1.91$). I use the difference between these two numbers (\$9,298) as the additional special education cost incurred per school year. See J.G. Chambers., J. Shkolnik and M. Perez, “Total expenditures for students with disabilities, 1999–2000: Spending variation by disability. Report 5, Special Education Expenditure Project (SEEP),” 2003, Washington, DC: United States Department of Education, Office of Special Education Programs, American Institutes for Research (available at <https://eric.ed.gov/?id=ED481398>), see p. v for quote. See National Center for Education Statistics, Table 236.15 for cost per pupil (available at https://nces.ed.gov/programs/digest/d17/tables/dt17_236.15.asp) and Table 204.30 for percent of total enrollment for children with disabilities (available at https://nces.ed.gov/programs/digest/d17/tables/dt17_204.30.asp).

⁸ E.W. Holt, D.J. McGrath, W.L. Herring, “Timing and Duration of Student Participation in Special Education in the Primary Grades, NCES, 2007-043, Washington DC, National Center for Education Statistics, 2007; A.A. Scarborough, J.S. McCrae, “Reported Eligibility for Part C and Later School-Age Special Education Services,” *Topics in Early Childhood Special Education*, 28(2), 2008, pp. 75-89.

⁹ Currie & Widom 2010, *op cit.*

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adulthood,¹⁰ and are significantly less likely to attend 4-year college,¹¹ than other children. Additionally, children who experience maltreatment have higher rates of substance misuse and depression in adulthood than other children.¹² Finally, there are direct costs associated with child welfare.¹³ None of these costs are reflected in the estimates presented here.

Table G.2a
Cases and Valuation of Maltreatment due to Opioid Shipments, 2006-2016
Cuyahoga County
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment [1]	2,043	1,924	2,073	1,452	1,738	2,092	2,156	2,502	2,281	2,316	2,513	23,090
Share Harms Due to Opioid Shipments [2]	2.2%	2.7%	3.2%	3.7%	4.0%	4.2%	4.8%	6.6%	8.2%	9.6%	13.5%	
Maltreatment Victims Due to Opioid Shipments	45	52	65	53	70	88	104	164	186	222	340	1,391
Social Cost of Maltreatment by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment Due to Opioid Shipments												
Productivity Losses (\$mil)	\$13.0	\$14.8	\$18.7	\$15.3	\$20.0	\$25.2	\$29.7	\$47.0	\$53.3	\$63.6	\$97.3	\$397.9
Special Education Costs (\$mil)	\$0.1	\$0.1	\$0.1	\$0.1	\$0.1	\$0.2	\$0.2	\$0.3	\$0.4	\$0.4	\$0.7	\$2.7
Total valuation (\$mil)	\$13.1	\$14.9	\$18.9	\$15.4	\$20.1	\$25.4	\$29.9	\$47.3	\$53.7	\$64.0	\$97.9	\$400.6

[1] Young Report, Graphic 12.

[2] Cutler Report, Appendix III.I, Table I.6.

Estimates rounded to the nearest whole number.

¹⁰ Currie & Widom 2010, *op cit*.

¹¹ .P. Mersky and J. Topitzes, "Comparing Early Adult Outcomes of Maltreated and Non-Maltreated Children: A Prospective Longitudinal Investigation," *Children and Youth Services Review*, 32, 2010, pp. 1086-1096.

¹² J Mersky and Topitzes, *op cit*.; and C.S. Widom, K. Dumont and S.J. Czaja, "A Prospective Investigation of Major Depressive Disorder and Comorbidity in Abused and Neglected Children Grown Up," *Archives of General Psychiatry*, 2007, 64, 2007, pp. 49-56.

¹³ Fang *et al.* 2012, *op cit*.

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Table G.2b
Cases and Valuation of Maltreatment due to Opioid Shipments, 2006-2016
Summit County
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment [1]	1,319	1,117	901	944	715	643	674	601	579	757	886	9,136
Share Harms Due to Opioid Shipments [2]	2.1%	2.6%	3.3%	4.6%	12.0%	12.2%	15.5%	18.3%	19.5%	21.8%	27.5%	
Maltreatment Victims Due to Opioid Shipments	28	29	30	44	86	79	105	110	113	165	244	1,031
Social Cost of Maltreatment by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment Due to Opioid Shipments												
Productivity Losses (\$mil)	\$8.1	\$8.2	\$8.6	\$12.5	\$24.5	\$22.5	\$29.9	\$31.5	\$32.3	\$47.2	\$69.7	\$294.9
Special Education Costs (\$mil)	\$0.1	\$0.1	\$0.1	\$0.1	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.3	\$0.5	\$2.0
Total valuation (\$mil)	\$8.1	\$8.2	\$8.6	\$12.6	\$24.7	\$22.6	\$30.1	\$31.7	\$32.5	\$47.6	\$70.1	\$296.9

[1] Young Report, Graphic 13.

[2] Cutler Report, Appendix III.I, Table I.7.

Estimates rounded to the nearest whole number.

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Table G.3a
Cases and Valuation of Maltreatment due to Opioid Shipments, 2006-2016
Cuyahoga County
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment [1]	2,043	1,924	2,073	1,452	1,738	2,092	2,156	2,502	2,281	2,316	2,513	23,090
Share Harms Due to Opioid Shipments [2]	3.8%	4.6%	5.3%	5.4%	5.7%	6.0%	6.1%	7.6%	9.0%	10.0%	13.9%	
Maltreatment Cases Due to Opioid Shipments	77	88	109	79	100	126	131	190	205	232	348	1,685
Social Cost of Neglect by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment Due to Opioid Shipments												
Productivity Losses (\$mil)	\$22.1	\$25.2	\$31.3	\$22.5	\$28.5	\$35.9	\$37.6	\$54.4	\$58.7	\$66.3	\$99.6	\$482.0
Special Education Costs (\$mil)	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.3	\$0.4	\$0.4	\$0.5	\$0.7	\$3.3
Total valuation (\$mil)	\$22.3	\$25.4	\$31.5	\$22.6	\$28.7	\$36.2	\$37.8	\$54.8	\$59.1	\$66.8	\$100.2	\$485.3

[1] Young Report, Graphic 12.

[2] Cutler Report, Appendix III.I, Table I.6.

Estimates rounded to the nearest whole number.

Table G.3b
Cases and Valuation of Maltreatment due to Opioid Shipments, 2006-2016
Summit County
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment [1]	1,319	1,117	901	944	715	643	674	601	579	757	886	9,136
Share Harms Due to Opioid Shipments [2]	3.6%	4.4%	5.5%	6.8%	17.1%	17.4%	19.6%	21.2%	21.5%	22.8%	28.1%	
Maltreatment Cases Due to Opioid Shipments	48	49	50	64	122	112	132	127	124	172	249	1,251
Social Cost of Neglect by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment Due to Opioid Shipments												
Productivity Losses (\$mil)	\$13.7	\$13.9	\$14.3	\$18.4	\$35.0	\$32.1	\$37.8	\$36.4	\$35.5	\$49.3	\$71.3	\$357.7
Special Education Costs (\$mil)	\$0.1	\$0.1	\$0.1	\$0.1	\$0.2	\$0.2	\$0.3	\$0.2	\$0.2	\$0.3	\$0.5	\$2.4
Total valuation (\$mil)	\$13.8	\$14.0	\$14.4	\$18.5	\$35.2	\$32.3	\$38.0	\$36.7	\$35.8	\$49.6	\$71.8	\$360.2

[1] Young Report, Graphic 13.

[2] Cutler Report, Appendix III.I, Table I.7.

Estimates rounded to the nearest whole number.

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Appendix H
Technical Memo re Health Care Costs

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Appendix H

Technical Memo re Health Care Costs

This appendix summarizes my approach to estimating excess healthcare costs resulting from opioid use disorder (OUD) attributable to opioid shipments in the Bellwether communities. To summarize, I estimate the excess healthcare costs by insurer type from the academic literature and apply those per-person estimates to the number of people in the Bellwether communities with OUD attributable to opioid shipments.

There are three primary inputs into this analysis: 1) the number of individuals with OUD attributable to opioid shipments in the Bellwether communities; 2) the distribution of individuals with OUD with respect to the type of insurance coverage; and 3) published estimates of excess healthcare costs incurred by individuals with OUD.

Number of Individuals with OUD Attributable to Opioid Shipments:

The first input to the analysis is the number of individuals with OUD attributable to opioid shipments in each year from 2006 through 2016. See Appendix D for a discussion of the prevalence rates of OUD. The calculation of persons with OUD due to shipments for each of the counties is shown below in Tables H.1a and H.1b for Approach 1 and Tables H.2a and H.2b for Approach 2.¹

¹ Prevalence of OUD from Appendix D of this Report. County Population from U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (NCHS), Bridged Race Population Estimates. Share of Harm Due to Shipments are from Cutler Report, Appendix III.I, Tables I.4 and I.5.

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Table H.1a
Persons with OUD Due to Opioid Shipments, Cuyahoga County, Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	12,040.8
Person-years with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	
Share of Harm Due to Shipments[3]	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Person-years with OUD Due to Opioid Shipments (000s)	6.49	6.40	6.73	7.82	8.22	8.89	11.19	11.99	13.42	13.62	13.73	108.52

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.4

Table H.1b
Persons with OUD Due to Opioid Shipments, Summit County, Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Person-years with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	
Share of Harm Due to Shipments[3]	49.2%	50.4%	51.1%	52.4%	54.6%	57.6%	66.5%	74.3%	80.9%	87.3%	90.7%	
Person-years with OUD Due to Opioid Shipments (000s)	2.68	2.67	2.82	3.29	3.48	3.79	4.78	5.13	5.76	5.86	5.92	46.18

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.4

Table H.2a
Persons with OUD Due to Opioid Shipments, Cuyahoga County, Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 + (000s)	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	
Persons with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Persons with OUD Due to Opioid Shipments (000s)	11.0	10.9	11.2	11.5	11.7	12.7	14.1	13.9	14.8	14.2	14.1	140.1

Table H.2b
Persons with OUD Due to Opioid Shipments, Summit County, Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD[1]	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 Years and Older(000s)[2]	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Person-years with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	
Share of Harm Due to Shipments[3]	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Person-years with OUD Due to Opioid Shipments (000s)	4.57	4.54	4.71	4.84	4.96	5.40	6.04	5.94	6.34	6.12	6.06	59.50

[1] See OUD backup.

[2] CDC Bridged-Race Population Estimates, 2006-2016.

[3] Expert Report of Professor David Cutler, March 25, 2019, Appendix III.I, Table I.5

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Insurance Distribution for OUD Individuals:

The second input to the analysis is the distribution of the type of insurance coverage for individuals with OUD. Excess healthcare costs used in the third step of this analysis, vary by type of insurance coverage.

The distribution of type of insurance is constructed from two sources of data. First, the Henry J. Kaiser Family Foundation (KFF) reports the type of insurance coverage for adults under age 65 in the United States with opioid addiction (OUD) in 2005, 2010, 2015 and 2016.² I use linear interpolation to estimate the insurance shares for the nonelderly population for years not surveyed (interpolated values are shaded in gray). See Table H.3.

Table H.3
Insurance Status of Nonelderly Adults with Opioid Addiction

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Uninsured	33%	32.8%	32.6%	32.4%	32.2%	32%	29.6%	27.2%	24.8%	22.4%	20%	17%
Other	8%	8.0%	8.0%	8.0%	8.0%	8%	8.4%	8.8%	9.2%	9.6%	10%	8%
Private	42%	41%	40.0%	39.0%	38.0%	37%	37.6%	38.2%	38.8%	39.4%	40%	37%
Medicaid	17%	18.2%	19.4%	20.6%	21.8%	23%	24.4%	25.8%	27.2%	28.6%	30%	38%

Sources: The Henry J. Kaiser Family Foundation, "The Opioid Epidemic and Medicaid's Role in Treatment: A Look at Changes Over Time" (<https://www.kff.org/slideshow/the-opioid-epidemic-and-medicoids-role-in-treatment-a-look-at-changes-over-time/>); Zur, Julia and Jennifer Tolbert, "The Opioid Epidemic and Medicaid's Role in Facilitating Access to Treatment," The Henry J. Kaiser Family Foundation, April 11, 2018, (<https://www.kff.org/medicaid/issue-brief/the-opioid-epidemic-and-medicoids-role-in-facilitating-access-to-treatment/>).

Notes: Shaded cells estimated using linear interpolation.

Estimates of the share of individuals with OUD that are covered by Medicare are based on demographic data from the National Survey on Drug Use and Health (NSDUH).³ I assume that all persons with OUD who are 65 years and older are covered by Medicare. These surveys collect demographic information on the share of OUD individuals in the United States who are

² The Henry J. Kaiser Family Foundation (KFF), "The Opioid Epidemic and Medicaid's Role in Facilitating Access to Treatment," April 11, 2018, available at <https://www.kff.org/medicaid/issue-brief/the-opioid-epidemic-and-medicoids-role-in-facilitating-access-to-treatment/>; and The Henry J. Kaiser Family Foundation, "The Opioid Epidemic and Medicaid's Role in Treatment: A Look at Changes Over Time," June 29, 2017, available at <https://www.kff.org/slideshow/the-opioid-epidemic-and-medicoids-role-in-treatment-a-look-at-changes-over-time/>.

I refer to "opioid addiction" as referred to in the KFF reports as OUD throughout this appendix and in my analysis.

³ Substance Abuse and Mental Health Services, National Survey on Drug Use and Health (<https://nsduhweb.rti.org/respweb/homepage.cfm>).

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65 years and older. Because sample sizes for each year are small, I use a population-weighted average share calculated using data pooled from 2006-2014 and 2015-2017, respectively.⁴ See Table H.4.

Table H.4
Share of OUD Population 65 and Over

Share of OUD Population 65 and over											
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Share 65+	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%

Source: NSDUH (https://pdas.samhsa.gov/#/survey/NSDUH-2015-DS0001?column=UDPYOPI&results_received=true&row=CATAG6&weight=ANALWT_C); (https://pdas.samhsa.gov/#/survey/NSDUH-2016-DS0001?column=UDPYOPI&results_received=true&row=CATAG6&weight=ANALWT_C).

Note: The share used for 2006-2014 is the population-weighted share of the OUD population that is 65 years and over during the same, 2006-2014, period. Similarly, the 2015-2016 share is the population-weighted share during the 2015-2016 period.

I combine the Medicare estimates and insurance estimates for the nonelderly population to obtain estimates for the insurance status of all adults with OUD in 2006-2016. For example, in 2006, 1.5 percent of the OUD population was 65 years and older.⁵ I use this Medicare share to recalculate the KFF nonelderly shares for the total population. In 2006, 41 percent of the nonelderly population had private insurance and 97.7 percent of the population was nonelderly. Therefore, 40 percent (41% x 97.7%) of the total population with OUD had private insurance. See Table H.5 for the insurance distribution of all adults with opioid addiction.

Table H.5
Insurance Status for US Population with Opioid Addiction

Insurance Status for US Population with Opioid Addiction											
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Private	40%	39%	38%	37%	36%	37%	37%	38%	39%	39%	36%
Medicare	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%
Medicaid	18%	19%	20%	21%	22%	24%	25%	27%	28%	29%	37%
Uninsured	32%	32%	32%	31%	31%	29%	27%	24%	22%	20%	17%
Other	8%	8%	8%	8%	8%	8%	9%	9%	9%	10%	8%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

⁴ The NSDUH survey changed in 2015 making it more appropriate to pool samples separately before and after the survey change.

⁵ See raw data from NSDUH for population references in this paragraph.

Excess Healthcare Costs Resulting from OUD

The final input in this analysis is the estimated excess healthcare costs, which come from Florence *et al.* (2016).⁶ Florence *et al.* use a “matched case-control design” to estimate excess healthcare costs incurred by individuals with a diagnosis for opioid abuse and/or dependence. Using Truven Health MarketScan Research Databases for commercial, Medicare and Medicaid enrollees, they identify individuals with an opioid abuse/dependence diagnosis and match them to individuals with similar age and health characteristics who did not have an opioid abuse/dependence diagnosis.⁷ For the opioid abuse patient, they track healthcare utilization and costs for a 12-month period starting on the “index date,” which is the first occurrence of an opioid abuse/dependence diagnosis in the data. For the control patient, they measure healthcare utilization and costs for a 12-month period starting with an “index date” based on the selection of a random medical claim in the data. By comparing the costs for the matched pairs, they estimate an excess annual per person healthcare cost for individuals with opioid abuse/dependence.

This analysis yields estimates of annual excess healthcare costs for 2013 of \$17,052 for a patient covered by Medicare; \$15,500 for a patient covered by private insurance and \$13,743 for a patient covered by Medicaid. All costs are in 2013 dollars. When using these estimates to create aggregate costs, Florence *et al.* assign private insurance costs to CHAMPUS/VA and other insurance categories and they assign 50 percent of the private insurance cost to the uninsured.⁸ These 2013 estimates are adjusted to other years using the Medical Care CPI for the Midwest

⁶ C.S. Florence, *et al.*, “The Economic Burden of Prescription Opioid Overdose, Abuse, and Dependence in the United States, 2013” *Medical Care*, October 2016, 54(10), pp. 901-906.

⁷ The Florence *et al. op cit.* paper estimates the economic burden of prescription opioids, however, they acknowledge that the medical claims data do not allow them to distinguish between individuals with prescription and illicit opioid abuse/dependence so the excess healthcare costs they estimate applies to both types of opioid abuse.

⁸ Florence *et al., op cit.*, p. 903.

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Census Region.⁹ See Table H.6 for excess healthcare costs expressed in nominal dollars for each year 2006-2016. The 2013 values from Florence *et al.* are shaded gray.

Table H.6
Per Person Excess Costs by Type of Insurer

Per Person Excess Costs by Type of Insurer											
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Private	\$ 12,171	\$ 12,725	\$ 13,111	\$ 13,573	\$ 14,032	\$ 14,471	\$ 15,046	\$ 15,500	\$ 15,966	\$ 16,357	\$ 17,007
Medicare	\$ 13,390	\$ 13,999	\$ 14,423	\$ 14,932	\$ 15,437	\$ 15,920	\$ 16,553	\$ 17,052	\$ 17,565	\$ 17,995	\$ 18,709
Medicaid	\$ 10,791	\$ 11,283	\$ 11,624	\$ 12,035	\$ 12,442	\$ 12,830	\$ 13,341	\$ 13,743	\$ 14,156	\$ 14,503	\$ 15,079
Uninsured	\$ 6,085	\$ 6,363	\$ 6,555	\$ 6,787	\$ 7,016	\$ 7,235	\$ 7,523	\$ 7,750	\$ 7,983	\$ 8,178	\$ 8,503
Other	\$ 12,171	\$ 12,725	\$ 13,111	\$ 13,573	\$ 14,032	\$ 14,471	\$ 15,046	\$ 15,500	\$ 15,966	\$ 16,357	\$ 17,007

Estimating Excess Healthcare Costs

These three inputs are multiplied together to obtain annual estimates of the excess healthcare costs resulting from opioid shipments in 2006 through 2016. Table H.7a contains these calculations for Cuyahoga County using Professor Cutler's Approach 1.

For example, there were 6,491 people in Cuyahoga County in 2006 with OUD attributable to opioid shipments. Forty percent of those individuals ($6,491 \times 40\% = 2,596$) are covered by private insurance. The estimated healthcare costs for those 2,596 people in 2006 dollars is \$31.6 million ($\$12,171 \times 2,596$). This calculation is repeated for all insurance categories in 2006 and the total excess cost of healthcare in 2006 is \$64.9 million.

Similar analysis was conducted for Summit County, results reported in Table H.7b.

Similar analysis was conducted for Cuyahoga and Summit counties for Dr. Cutler's Approach 2 and the results appear in Tables H.8a and H.8b.

Tables 7a and 7b in my Report include these calculations as part of my valuation for excess costs attributed to morbidity.

⁹ Bureau of Labor Statistics, CPI-U Midwest: Medical Care. The monthly cost indices are averaged to create annual estimates for 2006-2016.

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Table H.7a
Excess Healthcare Costs
Cuyahoga County
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Person-years with OUD Due to Opioid Shipments (000s)	6.49	6.40	6.73	7.82	8.22	8.89	11.19	11.99	13.42	13.62	13.73	108.52
Distribution of Population by Type of Insurance ^[1]												
Private Insurance	40%	39%	38%	37%	36%	37%	37%	38%	39%	39%	36%	
Medicare	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Medicaid	18%	19%	20%	21%	22%	24%	25%	27%	28%	29%	37%	
Uninsured	32%	32%	32%	31%	31%	29%	27%	24%	22%	20%	17%	
Other	8%	8%	8%	8%	8%	8%	9%	9%	9%	10%	8%	
Per Person Excess Costs by Type of Insurer ^[2]												
Private Insurance	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Medicare	\$13,390	\$13,999	\$14,423	\$14,932	\$15,437	\$15,920	\$16,553	\$17,052	\$17,565	\$17,995	\$18,709	
Medicaid	\$10,791	\$11,283	\$11,624	\$12,035	\$12,442	\$12,830	\$13,341	\$13,743	\$14,156	\$14,503	\$15,079	
Uninsured ^[3]	\$6,085	\$6,363	\$6,555	\$6,787	\$7,016	\$7,235	\$7,523	\$7,750	\$7,983	\$8,178	\$8,503	
Other ^[4]	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Excess Healthcare Costs (000s)	\$ 64,929	\$ 66,922	\$ 72,470	\$ 87,083	\$ 94,678	\$106,887	\$141,602	\$158,154	\$184,536	\$194,115	\$204,770	\$1,376,145

Sources: Morbidity Estimates; Kaiser Family Foundation; NSDUH; Florence et al. (2016), Bureau of Labor Statistics, Midwest Medical Care CPI.

Notes: [1] Medicare share based on NSDUH OUD population demographics (65 yrs and over). Other insurance shares based on Kaiser estimates for of insurance status for nonelderly adults with opioid addiction.

[2] Florence et al. (2016) excess cost estimates from 2013 are scaled to each year using the Midwest Medical Care CPI.

[3] Uninsured are assigned costs equal to 50% of private insurance rate. Florence et al. (2016), p. 903.

[4] OUD individuals with "other" insurance are assigned costs for private insurance. Florence et al. (2016), p. 903.

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Table H.7b
Excess Healthcare Costs
Summit County
Approach 1

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Person-years with OUD Due to Opioid Shipments (000s)	2.68	2.67	2.82	3.29	3.48	3.79	4.78	5.13	5.76	5.86	5.92	46.18
Distribution of Population by Type of Insurance ^[1]												
Private Insurance	40%	39%	38%	37%	36%	37%	37%	38%	39%	39%	36%	
Medicare	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Medicaid	18%	19%	20%	21%	22%	24%	25%	27%	28%	29%	37%	
Uninsured	32%	32%	32%	31%	31%	29%	27%	24%	22%	20%	17%	
Other	8%	8%	8%	8%	8%	8%	9%	9%	9%	10%	8%	
Per Person Excess Costs by Type of Insurer ^[2]												
Private Insurance	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Medicare	\$13,390	\$13,999	\$14,423	\$14,932	\$15,437	\$15,920	\$16,553	\$17,052	\$17,565	\$17,995	\$18,709	
Medicaid	\$10,791	\$11,283	\$11,624	\$12,035	\$12,442	\$12,830	\$13,341	\$13,743	\$14,156	\$14,503	\$15,079	
Uninsured ^[3]	\$6,085	\$6,363	\$6,555	\$6,787	\$7,016	\$7,235	\$7,523	\$7,750	\$7,983	\$8,178	\$8,503	
Other ^[4]	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Total Excess Healthcare Costs	\$ 26,845	\$ 27,889	\$ 30,379	\$ 36,638	\$ 40,043	\$ 45,509	\$ 60,465	\$ 67,707	\$ 79,208	\$ 83,548	\$ 88,293	\$ 586,524

Source: Morbidity Estimates; Kaiser Family Foundation; NSDUH; Florence et al. (2016), Bureau of Labor Statistics, Midwest Medical Care CPI.

Notes: [1] Medicare share based on NSDUH OUD population demographics (65 yrs and over). Other insurance shares based on Kaiser estimates for of insurance status for nonelderly adults with opioid addiction.

[2] Florence et al. (2016) excess cost estimates from 2013 are scaled to each year using the Midwest Medical Care CPI.

[3] Uninsured are assigned costs equal to 50% of private insurance rate. Florence et al. (2016), p. 903.

[4] OUD individuals with "other" insurance are assigned costs for private insurance. Florence et al. (2016), p. 903.

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Table H.8a
Excess Healthcare Costs
Cuyahoga County
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Person-years with OUD Due to Opioid Shipments (000s)	11.04	10.89	11.23	11.51	11.72	12.68	14.14	13.87	14.76	14.21	14.05	140.12
Distribution of Population by Type of Insurance ^[1]												
Private Insurance	40%	39%	38%	37%	36%	37%	37%	38%	39%	39%	36%	
Medicare	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Medicaid	18%	19%	20%	21%	22%	24%	25%	27%	28%	29%	37%	
Uninsured	32%	32%	32%	31%	31%	29%	27%	24%	22%	20%	17%	
Other	8%	8%	8%	8%	8%	8%	9%	9%	9%	10%	8%	
Per Person Excess Costs by Type of Insurer ^[2]												
Private Insurance	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Medicare	\$13,390	\$13,999	\$14,423	\$14,932	\$15,437	\$15,920	\$16,553	\$17,052	\$17,565	\$17,995	\$18,709	
Medicaid	\$10,791	\$11,283	\$11,624	\$12,035	\$12,442	\$12,830	\$13,341	\$13,743	\$14,156	\$14,503	\$15,079	
Uninsured ^[3]	\$6,085	\$6,363	\$6,555	\$6,787	\$7,016	\$7,235	\$7,523	\$7,750	\$7,983	\$8,178	\$8,503	
Other ^[4]	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Excess Healthcare Costs (000s)	\$110,449	\$113,818	\$120,907	\$128,189	\$134,962	\$152,435	\$178,895	\$182,959	\$202,994	\$202,525	\$209,613	\$1,737,746

Sources: Morbidity Estimates; Kaiser Family Foundation; NSDUH; Florence et al. (2016), Bureau of Labor Statistics, Midwest Medical Care CPI.

Notes: [1] Medicare share based on NSDUH OUD population demographics (65 yrs and over). Other insurance shares based on Kaiser estimates for of insurance status for nonelderly adults with opioid addiction.

[2] Florence et al. (2016) excess cost estimates from 2013 are scaled to each year using the Midwest Medical Care CPI.

[3] Uninsured are assigned costs equal to 50% of private insurance rate. Florence et al. (2016), p. 903.

[4] OUD individuals with "other" insurance are assigned costs for private insurance. Florence et al. (2016), p. 903.

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Table H.8b
Excess Healthcare Costs
Summit County
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Person-years with OUD Due to Opioid Shipments (000s)	4.57	4.54	4.71	4.84	4.96	5.40	6.04	5.94	6.34	6.12	6.06	59.50
Distribution of Population by Type of Insurance ^[1]												
Private Insurance	40%	39%	38%	37%	36%	37%	37%	38%	39%	39%	36%	
Medicare	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Medicaid	18%	19%	20%	21%	22%	24%	25%	27%	28%	29%	37%	
Uninsured	32%	32%	32%	31%	31%	29%	27%	24%	22%	20%	17%	
Other	8%	8%	8%	8%	8%	8%	9%	9%	9%	10%	8%	
Per Person Excess Costs by Type of Insurer ^[2]												
Private Insurance	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Medicare	\$13,390	\$13,999	\$14,423	\$14,932	\$15,437	\$15,920	\$16,553	\$17,052	\$17,565	\$17,995	\$18,709	
Medicaid	\$10,791	\$11,283	\$11,624	\$12,035	\$12,442	\$12,830	\$13,341	\$13,743	\$14,156	\$14,503	\$15,079	
Uninsured ^[3]	\$6,085	\$6,363	\$6,555	\$6,787	\$7,016	\$7,235	\$7,523	\$7,750	\$7,983	\$8,178	\$8,503	
Other ^[4]	\$12,171	\$12,725	\$13,111	\$13,573	\$14,032	\$14,471	\$15,046	\$15,500	\$15,966	\$16,357	\$17,007	
Total Excess Healthcare Costs	\$ 45,666	\$ 47,433	\$ 50,683	\$ 53,933	\$ 57,081	\$ 64,902	\$ 76,389	\$ 78,326	\$ 87,130	\$ 87,167	\$ 90,382	\$ 739,092

Source: Morbidity Estimates; Kaiser Family Foundation; NSDUH; Florence et al. (2016), Bureau of Labor Statistics, Midwest Medical Care CPI.

Notes: [1] Medicare share based on NSDUH OUD population demographics (65 yrs and over). Other insurance shares based on Kaiser estimates for of insurance status for nonelderly adults with opioid addiction.

[2] Florence et al. (2016) excess cost estimates from 2013 are scaled to each year using the Midwest Medical Care CPI.

[3] Uninsured are assigned costs equal to 50% of private insurance rate. Florence et al. (2016), p. 903.

[4] OUD individuals with "other" insurance are assigned costs for private insurance. Florence et al. (2016), p. 903.

Model Assumptions

The insurance distribution estimates used in this analysis are based on national data, which are assumed to approximate the distribution for the Bellwether communities. Pooled 2002-2014 NSDUH data by state show that the US and Ohio insurance distributions are similar.¹⁰

The OUD estimates from the morbidity analysis are person-years, meaning that the same person may have OUD in multiple years. The Florence *et al.* analysis measures excess healthcare costs in the 12-month period following the first appearance of an opioid abuse/dependency diagnosis in the data. My estimates assume that excess healthcare costs are the same in each year a person has OUD. This will tend to overstate healthcare costs

¹⁰ See SAMHDA, National Survey on Drug Use and Health 2002-2014, pooled 2002-2014 NSDUH data (ages 12 and over), available at <https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/Supplemental%20NSDUH%20Opioid%20Tables/heroin%20pain%20halluc%20use%20and%20disorder%20by%20state.xlsx>.

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associated with OUD to the degree costs in the first year exceed costs in subsequent years, for the reason that some of the individuals counted each year will be “continuing” and therefore have lower healthcare costs in comparison to the new cases. On the other hand, these estimates tend to understate health care costs because individuals who are diagnosed with OUD are more expensive than others in the time leading up to their diagnosis on the index date. Kirson *et al.* (2017)¹¹ shows elevated costs pre and post index diagnosis on a monthly basis. Costs appear to be elevated more in the first month or two after diagnosis, but these elevations are roughly balanced by the higher health care costs in the run up to diagnosis. In light of these countervailing effects, it is reasonable to use the elevated cost per person year as an estimate of the excess costs associated with OUD.

¹¹ N.Y. Kirson, *et al.*, “The Economic Burden of Opioid Abuse: Updated Findings,” *Journal of Managed Care & Specialty Pharmacy*, 23(4), 2017, pp. 427-445.

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Appendix I
Analysis Using Dr. Cutler's Approach 2

Appendix I
Analysis Using Dr. Cutler's Approach 2

Tables 1, 2, 5a, 5b, 7a, 7b, 8a, 8b, 9a, 9b, 10a, 10b and 11 included in my Report are based on Dr. Cutler's Approach 1. In this appendix, I produce those same tables but using Dr. Cutler's Approach 2. The methodologies are the same as those presented in my Appendices C through H. Table 13 in my Report and Table I.1 below summarize the results of applying Dr. Cutler's Approach 2.

Table I.1
Summary of Monetary Value of Harms Due to Prescription Opioid Shipments
2006-2016
(\$millions)
Approach 2

Harms Due to Defendants' Shipments	Cuyahoga	Summit	Total
Excess deaths (\$mil)	\$13,306	\$6,059	\$19,366
Excess morbidity (\$mil)	\$1,738	\$739	\$2,477
Excess neonatal abstinence syndrome (\$mil)	\$11	\$8	\$19
Excess crimes (\$mil)	\$420	\$159	\$579
Excess child maltreatment (\$mil)	\$485	\$360	\$845
Excess costs to Bellwether governments (\$mil)	\$215	\$119	\$334
Totals (\$mil)	\$16,176	\$7,445	\$23,621

Sources: Tables I.5a, I.5b, I.7a, I.7b, I.8a, I.8b, I.9a, I.9b, I.10a, I.10b and I.11 of Attachment

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Table I.2
Summary of Harms Due to Opioid Shipments
2006-2016
Approach 2

Harm	Cuyahoga	Summit
Excess deaths	1,838	711
Excess morbidity	140	60
Excess neonatal abstinence syndrome	725	510
Excess crimes	57,019	26,245
Excess child maltreatment	1,685	1,251

Sources: Tables I.5a, I.5b, I.7a, I.7b, I.8a, I.8b, I.9a, I.9b, I.10a, and I.10b of Attachment I.

Table I.5a
Mortality and Valuation of Mortality Due to Opioid Shipments
Cuyahoga County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	104	87	111	92	138	185	191	223	234	245	504	2,114
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Opioid Deaths Due to Shipments	87	75	95	71	107	152	161	192	208	223	468	1,838
VSL (\$mil)	\$5.9	\$6.6	\$6.8	\$6.0	\$6.3	\$6.6	\$6.8	\$7.2	\$7.5	\$7.7	\$8.1	
Valuation (\$mil)	\$514	\$492	\$645	\$425	\$681	\$1,001	\$1,091	\$1,387	\$1,554	\$1,726	\$3,790	\$13,306

See Appendix C for sources and calculation notes.

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Table I.5b
Mortality and Valuation of Mortality Due to Opioid Shipments
Summit County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid Overdose Deaths	25	31	21	23	45	34	60	56	105	135	269	804
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Opioid Deaths Due to Shipments	21	27	18	18	35	28	50	48	93	123	250	711
VSL (\$mil)	\$6.5	\$7.1	\$7.8	\$7.3	\$7.2	\$7.6	\$8.2	\$8.4	\$8.7	\$8.9	\$9.1	
Valuation (\$mil)	\$136	\$189	\$139	\$130	\$251	\$211	\$412	\$402	\$814	\$1,093	\$2,282	\$6,059

See Appendix C for sources and calculation notes.

Table I.7a
Morbidity and Valuation of Morbidity Due to Shipments
Cuyahoga County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 + (000s)	1,117.2	1,109.9	1,103.5	1,099.4	1,094.7	1,089.4	1,087.5	1,087.9	1,086.8	1,083.7	1,080.9	12,040.8
Persons with OUD (000s)	13.2	12.7	13.2	14.9	15.1	15.4	16.8	16.1	16.6	15.6	15.1	
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Persons with OUD Due to Opioid Shipments (000s)	11.0	10.9	11.2	11.5	11.7	12.7	14.1	13.9	14.8	14.2	14.1	140.1
Elevated Health Costs (\$mil)	\$110	\$114	\$121	\$128	\$135	\$152	\$179	\$183	\$203	\$203	\$210	\$1,738

See Appendix D for sources and calculation notes.

Table I.7b
Morbidity and Valuation of Morbidity Due to Shipments
Summit County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Prevalence of OUD	1.2%	1.1%	1.2%	1.4%	1.4%	1.4%	1.5%	1.5%	1.5%	1.4%	1.4%	
County Population 12 + (000s)	461.9	462.5	462.6	462.5	463.0	463.8	464.4	465.7	466.5	466.4	466.1	5,105.5
Persons with OUD (000s)	5.5	5.3	5.5	6.3	6.4	6.6	7.2	6.9	7.1	6.7	6.5	
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
Persons with OUD Due to Opioid Shipments (000s)	4.6	4.5	4.7	4.8	5.0	5.4	6.0	5.9	6.3	6.1	6.1	59.5
Elevated Health Costs (\$mil)	\$46	\$47	\$51	\$54	\$57	\$65	\$76	\$78	\$87	\$87	\$90	\$739

See Appendix D for sources and calculation notes.

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Table I.8a
Neonatal Abstinence Syndrome (NAS) and Valuation
Cuyahoga County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid-Related NAS Cases	19	23	30	45	60	74	94	117	117	117	141	837
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
NAS Cases Due to Shipments	16	20	26	35	47	61	79	101	104	107	131	725
Excess Hospital Costs Due to NAS	\$12,885	\$19,525	\$18,795	\$22,276	\$18,587	\$15,731	\$14,671	\$15,153	\$16,823	\$14,011	\$13,397	
Valuation of NAS Health Costs Due to Shipments (\$ mil)	\$0.21	\$0.39	\$0.48	\$0.78	\$0.87	\$0.96	\$1.15	\$1.52	\$1.75	\$1.49	\$1.75	\$11.35

See Appendix E for sources and calculation notes.

Table I.8b
Neonatal Abstinence Syndrome (NAS) and Valuation
Summit County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Opioid-Related NAS Cases	13	16	20	31	41	50	63	89	89	89	89	589
Share of Harm Due to Shipments	83.7%	85.6%	85.2%	77.1%	77.8%	82.2%	84.1%	85.9%	89.0%	91.1%	92.8%	
NAS Cases Due to Shipments	11	14	17	24	32	41	53	76	79	81	83	510
Excess Hospital Costs Due to NAS	\$12,885	\$19,525	\$18,795	\$22,276	\$18,587	\$15,731	\$14,671	\$15,153	\$16,823	\$14,011	\$13,397	
Valuation of NAS Health Costs Due to Shipments (\$ mil)	\$0.14	\$0.26	\$0.33	\$0.52	\$0.59	\$0.65	\$0.78	\$1.15	\$1.33	\$1.13	\$1.11	\$7.99

See Appendix E for sources and calculation notes.

Table I.9a
Crime and Valuation of Crime Due to Shipments
Cuyahoga County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Crimes	4,484	4,304	5,142	4,645	4,986	5,316	5,872	5,369	5,426	5,677	5,799	57,019
Valuation of Crimes (\$mil)	\$32	\$33	\$36	\$34	\$35	\$36	\$41	\$38	\$39	\$45	\$51	\$420

See Appendix F for sources and calculation notes.

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Table I.9b
Crime and Valuation of Crime Due to Shipments
Summit County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Crimes	1,590	1,536	2,127	1,987	2,219	2,304	2,423	2,689	2,860	3,152	3,359	26,245
Valuation of Crimes (\$mil)	\$10	\$9	\$13	\$12	\$13	\$14	\$15	\$16	\$17	\$19	\$21	\$159

See Appendix F for sources and calculation notes.

Table I.10a
Child Maltreatment Cases and Valuation Due to Shipments
Cuyahoga County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment	2,043	1,924	2,073	1,452	1,738	2,092	2,156	2,502	2,281	2,316	2,513	23,090
Share Harms Due to Opioid Shipments	3.8%	4.6%	5.3%	5.4%	5.7%	6.0%	6.1%	7.6%	9.0%	10.0%	13.9%	
Maltreatment Victims Due to Opioid Shipments	77	88	109	79	100	126	131	190	205	232	348	1,685
Social Cost of Neglect by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment (\$mil)	\$22.3	\$25.4	\$31.5	\$22.6	\$28.7	\$36.2	\$37.8	\$54.8	\$59.1	\$66.8	\$100.2	\$485.3

See Appendix G for sources and calculation notes.

Table I.10b
Child Maltreatment and Valuation Due to Shipments
Summit County, 2006-2016
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Number of Child Victims of Maltreatment	1,319	1,117	901	944	715	643	674	601	579	757	886	9,136
Share Harms Due to Opioid Shipments	3.6%	4.4%	5.5%	6.8%	17.1%	17.4%	19.6%	21.2%	21.5%	22.8%	28.1%	
Maltreatment Victims Due to Opioid Shipments	48	49	50	64	122	112	132	127	124	172	249	1,251
Social Cost of Neglect by Category												
Productivity Losses (\$000s)	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	\$286.0	
Special Education Costs (\$000s)	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	
Total Social Costs (\$000s)	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	\$288.0	
Valuation of Child Maltreatment (\$mil)	\$13.8	\$14.0	\$14.4	\$18.5	\$35.2	\$32.3	\$38.0	\$36.7	\$35.8	\$49.6	\$71.8	\$360.2

See Appendix G for sources and calculation notes.

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Table I.11
Government Costs Attributable to Opioid Shipments
2006-2016 (millions)
Approach 2

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Cuyahoga County (\$mil)	\$11.0	\$12.6	\$15.8	\$15.3	\$16.7	\$18.1	\$18.6	\$21.9	\$24.3	\$26.8	\$33.7	\$214.7
Summit County (\$mil)	\$3.4	\$3.7	\$4.9	\$6.0	\$11.5	\$11.2	\$12.0	\$14.3	\$15.4	\$16.6	\$20.3	\$119.3
Total (\$mil)	\$14.3	\$16.3	\$20.6	\$21.4	\$28.2	\$29.3	\$30.7	\$36.2	\$39.7	\$43.4	\$54.0	\$334.0

Sources: McGuire Cost Report, Tables E.3 and E.4.

Note:

The estimates include damages incurred by the Summit and Cuyahoga governments. Damages incurred by the governments of the cities of Cleveland and Akron are not included, nor are damages incurred by other jurisdictions within the counties.

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